North Boeing Field and Georgetown Steam Plant

Summary of Existing Information and Identification of Data Gaps

Prepared for

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List of Acronyms

AFFF	aqueous fire fighting foam
ARFF	Aircraft Rescue and Fire Fighting
AST	aboveground storage tank
BEHP	bis(2-ethylhexyl)phthalate
bgs	below ground surface
BMP	best management practice
BTEX	benzene, toluene, ethylbenzene, and xylenes
CDWAA	Central Dangerous Waste Accumulation Area
CSCSL	Confirmed and Suspected Contaminated Sites List
CSL	Cleanup Screening Level
DW	dry weight
EPA	Environmental Protection Agency
ESA	Environmental Site Assessment
FAA	Federal Aviation Administration
FOG	fats, oil, and grease
GAC	granular activated carbon
GIS	geographic information systems
gpd	gallons per day
GPR	ground penetrating radar
GTSP	Georgetown Steam Plant
HPAH	high molecular weight polycyclic aromatic hydrocarbon
KCDDES	King County Department of Development and Environment Services
KCIA	King County International Airport
KCIW	King County Industrial Waste
LNAPL	light non-aqueous phase liquid
LPAH	low molecular weight polycyclic aromatic hydrocarbon
LUST	leaking underground storage tank
MEK	methyl ethyl ketone
MTCA	Washington State Model Toxics Control Act
NAPL	non-aqueous phase liquid
NBF	North Boeing Field
NBF-FTC	North Boeing Field Fire Training Center
NCCW	non-contact cooling water
NGVD	National Geodetic Vertical Datum
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
OC	organic carbon
OWS	oil/water separator
PAH	polynuclear aromatic hydrocarbons
PCB	polychlorinated biphenyls
PCE	tetrachloroethene
PEL	Propulsion Engineering Laboratory
PID	photoionization detector
RCRA	Resource Conservation and Recovery Act

SCAP	Source Control Action Plan
SCL	Seattle City Light
SEPA	State Environmental Policy Act
SMS	Sediment Management Standards
SPCC	Spill Prevention, Control and Countermeasure
SPU	Seattle Public Utilities
SQS	Sediment Quality Standards
SVOC	semi-volatile organic compound
SWPPP	Stormwater Pollution Prevention Plan
TCA	trichloroethane
TCE	trichloroethene
TCLP	Toxic Characteristic Leaching Procedure
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TRI	Toxics Release Inventory
TSCA	Toxic Substances Control Act
TTO	total toxic organics
UST	underground storage tank
VOC	volatile organic compound
WARM	Washington Ranking Method
WDNR	Washington Department of Natural Resources
WPCC	Water Pollution Control Commission

1.0 Introduction

Recent investigations have raised concerns about the contribution of contaminants associated with North Boeing Field and the Georgetown Steam Plant to potential recontamination of Slip 4 sediment following cleanup of the Slip 4 Early Action Area. This report comprises an evaluation of this potential by summarizing existing information on current and historic operations at these sites; evaluating available data on contaminants of concern in soil, groundwater, and storm drain systems; and identifying remaining data gaps.

1.1 Background

Sediments in Slip 4 contain chemical contaminants from numerous historical and potentially ongoing sources. Polychlorinated biphenyls (PCBs) and bis(2-ethylhexyl)phthalate (BEHP) are considered the contaminants of concern in Slip 4 sediments and are the primary focus of this evaluation. These chemicals entered the slip through direct discharges, bank erosion, groundwater discharges, surface water runoff, spills, and other non-point discharges.

Upland sites may contribute contaminants to Slip 4 through stormwater and other discharges to piped outfalls and through contaminated groundwater that may infiltrate into a stormwater system that discharges to the slip.

PCBs were found in Slip 4 sediments in the early 1980s. Metro sampled sediment in stormwater lines discharging to Slip 4, and PCBs were detected in the Seattle City Light (SCL) flume (referred to in this report as the Georgetown flume) immediately downstream from the Georgetown Steam Plant (GTSP) and North Boeing Field (NBF) (Ecology 1984). Subsequent investigations found PCBs in numerous storm drains and associated structures that drain from NBF to Slip 4.

Additional background information on Slip 4 is provided in the Slip 4 Source Control Action Plan (SCAP) (Ecology 2006).

1.2 Purpose

The major objective of this report was to document existing environmental conditions in the vicinity of North Boeing Field and the Georgetown Steam Plant. Soil and groundwater data have been compared to relevant regulatory criteria and guidelines, as appropriate. This report also defines data gaps that introduce uncertainty into the evaluation of sediment recontamination potential.

1.3 Scope and Limitations

Property boundaries, labels, and storm drain lines shown in many of the figures provided in this report were derived from the Seattle Public Utilities (SPU) geographic information systems (GIS) database, or from existing documents. Parcels, contours, water, transportation, and utility features were exported from the SPU/City of Seattle GIS database in May 2006. The date of the last update for parcels is unknown and not documented in the metadata.

This report uses original source documents, if they were available. Data and reports published after September 20, 2006 are not included in this report.. Information reviewed included aerial photos; King County tax records; and reports, maps, and data obtained from Ecology's Northwest Regional Office, Ecology Central Records, Washington State archives, Environmental Protection Agency (EPA), King County, City of Seattle, and Boeing; and personal communications as noted in Section 7.0, Documents Reviewed.

The primary focus of this report is the potential for recontamination of sediments with PCBs. PCBs are one of the most important contaminants of concern in Slip 4 and continue to be detected in the Slip 4 storm drain system, despite numerous efforts to remove contaminated soils and sediments that may be responsible. This report attempts to identify potential PCB sources at the Georgetown Steam Plant, North Boeing Field, and relevant adjoining properties.

Other chemicals of concern, such as metals, phthalates, pesticides, and other organics, are discussed in a less comprehensive way, but data and information are presented as appropriate and necessary to the identification of potential sediment recontamination sources.

The report focuses on the Georgetown Steam Plant and North Boeing Field, the source areas where PCBs have been identified. The Georgetown flume is a mechanism for transport of PCBs rather than a source; however, it is discussed as needed to document the presence and distribution of the contaminants. Relevant information from properties adjacent to the Georgetown Steam Plant and North Boeing Field, which may be the source of PCBs and other contaminants to the Slip 4 storm drain system (including King County International Airport), is also presented.

Additional information on contaminants of concern in Slip 4 sediments, potential sources of these contaminants, and source control actions that are planned or ongoing is presented in the Slip 4 Source Control Action Plan (Ecology 2006).

1.4 Report Organization

A series of GIS maps, using both line drawings and aerial photographs as the base, supplement the information provided. Section 2 provides an overview of the area of GTSP and NBF, including location, physical environment, and natural environment. Section 3 describes existing information about the Georgetown Steam Plant; although the Georgetown flume is not the focus of the current report, it is discussed in this section as it pertains to contaminants potentially originating from the Steam Plant. Section 4 summarizes existing information about North Boeing Field. Section 5 identifies potential sources of contaminants from adjacent properties, primarily

King County International Airport. Section 6 summarizes potential sources of sediment recontamination identified in earlier sections, both historic and ongoing, and identifies remaining data gaps. Section 7 presents a list of documents reviewed during the preparation of this report, including those specifically referenced. Appendices provide aerial photos, data tables, and other relevant materials.

2.0 Site Description

2.1 Site Location

The Seattle City Light steam plant, known as the Georgetown Steam Plant (GTSP), and North Boeing Field (NBF) are located northeast and east of Slip 4 respectively, and approximately 4 miles south of downtown Seattle.

The GTSP is located near the intersection of Warsaw and Ellis Avenue S., near the northwest corner of King County International Airport (KCIA) (Figure 1). The 7.29-acre property (tax parcel 7006700570) contains the old powerhouse, which currently houses the Georgetown Powerplant Museum. Below the five-level powerhouse is a condenser pit, which is connected to an underground concrete discharge tunnel that extends through a flume (known as the Georgetown flume) for a distance of approximately 0.4 mile into the head of Slip 4. Until the 1960s, the flume was used to discharge cooling water from the Steam Plant. At one time, the flume was a conduit for industrial wastewater discharges and runoff from an estimated 11.5 acres of the north end of the airport.

NBF occupies approximately 130 acres primarily within the city limits of Seattle. A small portion of the site lies within the Tukwila city limits. NBF is bounded to the northeast by Ellis Avenue S., the southeast by South Norfolk Street, the northeast by Airport Way, and the southwest by East Marginal Way S. (SEACOR 1996a). The site is leased by Boeing from King County with the exception of a few acres on either side of the GTSP flume, which is leased from the City of Seattle, and Building 3-390 and an adjacent parcel used for parking, which are owned by Boeing. The head of Slip 4 is approximately 150 feet from the northwestern boundary of NBF (SEA 2004). Surrounding land use is primarily industrial, except to the northwest along Ellis Avenue, which is residential. The 615-acre KCIA, a general aviation airport owned and operated by King County as a public utility, is located to the east of NBF. Much of the NBF site is an open, paved surface area used for aircraft taxiways and for parking (Landau 1993b).

2.2 Physical Environment

Topography in the general vicinity slopes gradually to the west towards the Duwamish Waterway.

2.2.1 Physiographic Setting

The NBF and GTSP sites are situated in the southern portion of the Puget Sound Lowland, a broad, relatively level glacial drift plain that is dissected by a network of deep marine embayments. The site is located within the north-south trending Duwamish Valley on the Duwamish River floodplain, formerly a marine embayment that has been filled with sediment since the end of the last glaciation, referred to as the Vashon Glaciation of Pleistocene age. The valley is bounded to the east and west by glacial uplands.

Quaternary sediments overlying bedrock in the site vicinity consist of relatively flat-lying interbedded glacial and non-glacial deposits. The older portion of the Quaternary section contains at least three non-glacial and two glacial sequences of deposits. The oldest non-glacial deposits are composed of moderately consolidated fluvial sand, silt, clay, and minor gravel. The oldest glacial unit (Beacon Hill Till) is a compact clayey till with well-rounded cobbles and pebbles. Interposed between the Beacon Hill Till and the next overlying glacial unit is a sequence of non-glacial fluvial and lacustrine sand, silt, clay, gravel, and peat known as the Duwamish Formation. The glacial unit overlying the Duwamish Formation is the Klinker Till, a unit lithologically similar to the Beacon Hill Till. Fluvial and lacustrine sediments similar in lithology to the Duwamish Formation make up the sequence of Olympia non-glacial sediments that overlie the Klinker Till.

Sediments, collectively termed the Vashon Drift, representing the last major advance and retreat of ice into Puget Sound, commonly overlie the sequence of older glacial and non-glacial sediments throughout the site vicinity. The preglacial-lacustrine Lawton Caly and pre-glacial-fluvial or lacustrine Esperance Sand sequence generally grades upward to coarse-grained, gravelly outwash deposits that accumulated in front of the advancing ice sheet. The Vashon Till overlies the advance outwash complex and consists of very compact clayey to sandy till containing abundant cobbles and boulders. Recessional outwash deposits overlying the Vashon Till generally consist of poorly sorted gravelly sands. Locally, recent alluvial deposits of gravel, sand, silt, and clay overlie the Vashon Drift.

Based on site reports, the uppermost subsurface soils in the NBF area consist of at least 75 feet of recent alluvium deposited by the Duwamish River which overlie the Vashon Drift deposits (SEACOR 1996b). Alluvial deposits consist primarily of sand and silty sand interbedded with silt and clay.

The Duwamish River was channeled to a straighter course between 1912 and 1918. The former river channel was supposedly filled with hydraulically dredged sand derived from the channelization project (Bridgewater Group 2000).

2.2.2 Hydrology

The principal surface drainage channel in the site vicinity is the Duwamish Waterway, which is located approximately 2,500 feet west of the site. The Duwamish River originates approximately 5 miles south of the site where it merges with the Green River. From this point, the river flows north into Elliott Bay on Puget Sound.

Groundwater in the site vicinity occurs at shallow depths under water-table conditions, within the recent alluvium. Based on site reports, depth to groundwater varies seasonally and generally occurs at depths from 4 to 12 feet below ground surface (bgs) (SEACOR 1996b). Groundwater generally flows to the west, towards the Duwamish Waterway, at a gradient of approximately 0.002 feet per foot (SEACOR 1992a).

2.3 Natural Environment

The NBF/GTSP area is highly industrialized and mostly paved, making this unsuitable habitat for most animals. The only unpaved areas include a grassy portion on the east side of the GTSP property, and isolated plantings associated with NBF parking lots and office buildings. Birds and mammals that have adapted to urban environments, such as gulls, sparrows, finches, swallows, and European starlings, as well as mice, squirrels, and bats, may occasionally be observed in this area.

3.0 Georgetown Steam Plant

The GTSP, a turbo-generator station, was constructed by the Seattle Electric Company in 1906 on 16 acres of land. The station's purpose was to provide Seattle Electric with additional peak load capacity; much of its power went to operate the utility's streetcars. In 1912, Puget Sound Power and Light Company purchased Seattle Electric Company (ASME 1980); thereafter, use of the GTSP declined. For a period of time, the station was used only to supply steam to the company's car barns.

After the Duwamish River was straightened in 1916 to form the Duwamish Waterway, a flume (known as the Georgetown flume) measuring 7 feet wide by 5 feet deep was connected to the discharge tunnel to transport cooling water to Slip 4 (SEA 2004). Except for annual test runs, routine cooling water discharges were discontinued in the 1960s when the GTSP was shut down (SEA 2004).

In 1951, the City of Seattle Department of Lighting (now Seattle City Light), purchased the GTSP. The plant's last production run was in the winter of 1964. In 1963, the northwestern portion of the original GTSP property was sold to King County.

Surrounding land use includes the KCIA runways located to the east of the site, buildings associated with Boeing's Propulsion Engineering Labs located to the south and southwest, the Washington Air National Guard and Washington State Department of Transportation facilities located to the west, and the King County truck maintenance facility located to the northwest of the site. Reportedly, Great Western Soil Conditioners, a company that hauls biosolids from King County's wastewater treatment plant, maintains its trucks at the King County facility (Bridgewater Group 2000).

City-owned property adjacent to the flume has been leased to Boeing. As industrial development occurred in the area, discharge pipes from nearby properties and facilities were connected to the flume at numerous locations along its length. These included both permitted and unpermitted connections for stormwater, cooling water, and industrial wastewater discharges.

Sampling conducted by EPA in 1982 identified elevated concentrations of metals, polynuclear aromatic hydrocarbons (PAHs), and PCBs in Slip 4; Metro samples from the flume sediments entering Slip 4 contained 13 mg/kg PCBs (Raven 1988). Additional flume samples identified PCBs in the flume at concentrations up to 520 mg/kg. The GTSP was identified as a potential source of PCBs and other contaminants to Slip 4 via the flume.

3.1 Current Operations

The Georgetown Steam Plant currently operates as the Georgetown Powerplant Museum. Current site features are depicted in Figure 2 and include the following:

Power House. The former GTSP power house, located in the northwest portion of the site, is divided into an ash room, boiler room, engine room, turbine room, and a series of galleries on five levels (Bridgewater Group 2000). A condenser pit is located beneath the power house; it is connected to an underground concrete discharge tunnel that was used in the past to discharge cooling water to the concrete and wooden Georgetown flume. At the time of a July 2000 site visit by Bridgewater Group, the west side of the power house was being used to stage equipment, including a steel tank, two pickup trucks, a cargo shipping container, and other equipment.

Water Reservoir: A circular concrete water reservoir is located near the northwest corner of the power house. It formerly held cooling water for one of the plant's turbine generators. At the time of a July 2000 site visit by Bridgewater Group, the reservoir contained water but there were no visible signs of a sheen or odor (Bridgewater Group 2000).

Flume: The Georgetown flume is connected to the discharge tunnel from the power house. The head of the flume (the most upstream portion) is partially open and partially covered for a distance of approximately 160 feet (Bridgewater Group 2000). The downstream end of the flume head is connected to buried, dual concrete pipes that extend for approximately 400 feet; these pipes connect to a short section of open concrete-lined flume and then to an open, wooden flume that runs south to its point of discharge at Slip 4.

Railroad and Sheds: A small railroad is used by museum visitors. Two small sheds are located near the east corner of the site. A shed in the southeast corner of the site contained cans of paint, paint thinner, grease, and oil at the time of a site visit in July 2000 (Bridgewater Group 2000).

The site currently has no storm drain structures. The roof of the steam plant building drains to the Georgetown flume. Stormwater infiltrates into the ground or flows into catch basins at North Boeing Field, to the south or west.

No pollutant sources associated with current operations of the GTSP site have been identified.

3.2 Historical Operations

Historical site features at the GTSP are shown in Figure 3. The powerhouse was built in 1906 by the Seattle Electric Company along an oxbow of the Duwamish River. It initially contained two turbo-generators: a 3,000 kW unit and an 8,000 kW unit, installed in 1907 and 1908, respectively. A third unit (10,000 kW) was installed in 1917 (ASME 1980). Its location along the Duwamish took advantage of the river as a source of cooling water for the condensers and for convenience in discharging wastewater (ASME 1980).

Early Years

The GTSP initially used fuel oil to fire the boilers. Then, from 1925 to 1945, the boilers were fired with coal. Coal was brought onto the site by rail across the north end of Boeing Field. A coal conveyer was operating at the south end of the plant where a large smokestack was located. This area later became the Boeing Fire Training Pit (Raven 1988).

The plant was converted to burn oil during World War II. At that time, the smokestacks were dismantled to allow airplane approaches. Bunker C fuel oil was delivered to the plant in rail cars and stored in three underground 12,000-gallon steel oil tanks near the south corner of the building (SCL 1988a). A 700-gallon diesel tank was located at the southwest corner of the GTSP. Fuel was also stored in a 150,000-gallon steel oil tank, located southwest of the power house.

An 800,000-gallon aboveground concrete oil storage tank was located to the northeast of the building. This tank held Bunker C fuel oil until May of 1987. Approximately 8 feet of its 15.7-foot height extended above the airport runway elevation (SCL 1988a).

Operation of the plant required cooling water. In the early days, the plant was located close to the deltaic channels and spent cooling water was discharged through a 250-foot long concrete tunnel into the channel. River water was pumped to supply the condensers at the GTSP through cooling coils and then discharged into the condenser pit. After dredging of the present Duwamish channel 2,500 feet to the west, an open timber flume was constructed from the tunnel mouth to drain the condenser water.

Boiler feed water was replaced after several cycles in the system to remove unwanted materials, such as chemical additives, corrosion products, and scale minerals. These wastewaters were channeled into a ditch (referred to as the blowdown ditch) and discharged into a low-lying area near the southwest corner of the site (Figure 3). The low-lying area and ditch were not directly connected to the flume, although there was an indirect connection. Overflow from the low-lying area ran into a storm drain to the south, which connected to the head of the flume (Raven 1988).

1960s

In 1961, Boeing was allowed to use an area east of the current GTSP property and north of KCIA, for fire drill training. This area is referred to as the North Boeing Field Fire Training Center (NBF-FTC) and is discussed further in Section 5.1. In 1963, King County purchased the northeastern portion of the GTSP property, which included the NBF-FTC, a large concrete oil storage tank, a warehouse, and a machinery shop (Bridgewater Group 2000).

A drainage ditch was located along the southern boundary of the GTSP site. The ditch formerly conveyed runoff from the northern portion of KCIA (including the NBF-FTC) and from the southeastern portion of the site to a low-lying area that was located southwest of the power house.

Some reports indicate that a transformer storage area may have been located near the southwest corner of the GTSP property (AGI 1998b); however, no specific information to support this assertion was found.

In 1967, the City of Seattle gave Boeing a temporary permit to conduct fire training in an area approximately 50 feet southeast of the GTSP. This area is referred to as the former Boeing Fire Training Pit, although there is no indication that it was ever a "pit." Aerial photographs show an airplane fuselage was present at the time in this location (Bridgewater Group 2000). The permit expired in 1974 (SEA 2004).

1970s

From 1971 to 1977, the GTSP was maintained on "cold standby" as part of a regional reserve for emergency situations (ASME 1980). It was officially retired in 1977. In 1978, it was listed on the National Register of Historic Places. In 1980, the site was designated a National Historic Mechanical Engineering Landmark (ASME 1980). In 1984, it became a City of Seattle Landmark, and a National Historic Landmark. Since 1987, the plant has been a museum.

1980s

In the early 1980s, in an attempt to identify the source of PCBs in Slip 4 sediments, Metro found PCBs in sediment samples from the Georgetown Flume immediately downstream of the GTSP and NBF. In response to Metro's findings, SCL began sampling the area around its plant during 1982 and 1983, including sediment at the head of the flume and soil around storage tanks. No PCB contamination was found (Ecology 1984).

In December 1983, SCL cleaned up a "small trash dump" just north of the low-lying area at the southwest corner of the SCL property, and filled in the boiler blowdown ditch (Ecology 1984).

A sampling program was conducted in 1984 to evaluate the presence and distribution of PCBs at the GTSP (SCL 1984b) (see Section 3.4). Based on the presence of PCBs in the low-lying area, SCL covered the drainage ditch and low-lying area (an area approximately 100 feet by 350 feet) with plastic (SCL 1985b), and King County diverted surface runoff from the northern part of KCIA to minimize flow into the ditch and low-lying area (SCL 1984c). SCL also proposed to install a series of sediment-control structures in the flume to trap and store sediments that may be moving downstream (SCL 1984c).

On January 3, 1984, a 6-inch water main valve broke and water flooded the entire floor of the GTSP. The water filled and overflowed drip pans and storage tanks containing lube oil. Approximately 100 to 400 gallons of oil floated out and down the flume. Samples of the lube oil indicated that it contained less than 5 mg/kg PCBs (SCL 1984a). In February 1985, another oil spill was identified in the flume; samples indicated PCB concentrations of 67 to 80 mg/kg (Ecology 1985a). The source of this oil spill was not identified (SCL 1985d).

A multi-stage cleanup of the low-lying area, the flume, and adjacent areas was conducted in 1985 (see Section 3.4).

In the spring of 1987, water and foam overflow from activities at the NBF-FTC was observed to flow down the old ditch channel on top of the plastic. In October of that year, the NBF-FTC was covered with plastic tarps (Raven 1988).

The large concrete oil tank northeast of the site was demolished in 1988. The three feed oil underground storage tanks (USTs) and the diesel tank were removed in 1989.

1990s

During 1995 to 1996, King County expanded its airport operations onto the site, including placement of soil piles on GTSP property (Bridgewater Group 2000); the piles were later graded by SCL. These are believed to be associated with a remedial action for removal of contaminated soils containing halogenated volatile organics, metals, and petroleum hydrocarbons being conducted at American Avionics, a KCIA tenant facility.

Additional information on historic operations at the GTSP is provided in a Preliminary Assessment conducted by Bridgewater Group (2001). More recent activities at the site are discussed in Section 3.4 below.

3.3 Permits and Inspections

The facility operated under National Pollutant Discharge Elimination System (NPDES) Permit No. WA-000328-0. In February 1976, EPA requested that the permit be modified to include a prohibition on discharge of PCBs "such as those commonly used for transformer fluid." (USEPA 1976). A revised permit was issued on May 17, 1976 (Ecology 1976). The permit was last revised in 1979.

Ecology's UST database lists four tanks associated with this facility (Site ID 8818), which were installed in 1964.[1] Three are identified as <20,000-gallon heating fuel tanks; the fourth is <1,000 gallons with unknown contents. All four have been removed.

In 1978, Ecology inspected the site and noted that the large concrete oil storage tank was leaking. Replacement of the tank and lining of two sumps in front of the tank was recommended (Bridgewater Group 2000).

In 1985, Ecology performed a preliminary site assessment of a number of historical and/or potential hazardous waste sites in Washington. The GTSP (along with North Boeing Field) was identified as a potential source of PCBs, lead, and petroleum products (Ecology 1985, as cited in (Bridgewater Group 2000)).

Ecology's Leaking Underground Storage Tank (LUST) database indicates that one LUST was present on the property (Release ID 1612); Ecology was notified of the leak on November 6, 1989, and cleanup was completed on April 27, 2000.[2]

In September 1999, the GTSP site was added to Ecology's confirmed and suspected contaminated sites list (CSCSL) because PCBs were suspected to be present in soil, groundwater, and sediment. In addition, petroleum products were confirmed in soil and

[1] Ecology Underground Storage Tank (UST) database, November 8, 2006. http://www.ecy.wa.gov/programs/tcp/ust-lust/ust-lst2.html

[2] Ecology Leaking Underground Storage Tank (LUST) list, November 16, 2006. http://www.ecy.wa.gov/programs/tcp/ust-lust/ust-lst2.html

suspected in groundwater.[3] Migration of PCBs from the site onto Boeing property and to the Duwamish River was suspected (Ecology 1999, as cited in (Bridgewater Group 2000).

A 2001 site hazard assessment conducted by Ecology and Public Health – Seattle & King County resulted in a Washington Ranking Method (WARM) rating of 5 out of 5 (the lowest level of concern for risk to human health and the environment). The site is currently listed in the CSCSL database as "ranked, awaiting remedial action."

3.4 Environmental Investigations and Cleanups

A number of environmental investigations have been conducted at the GTSP. Areas of chemical contamination have been identified on the property, in sediments of the flume, and in Boeing storm drains connected to the flume. Investigations and cleanups associated with potential contaminant contributions to the flume from NBF are described in Section 4. The following investigations are summarized in this section:

- Soil Sampling to Test for PCB Contamination, Georgetown Steam Plant: SCL Work Order #84-4 (Raven Systems & Research, Inc., September 1984)
- Sampling to Test for PCB Contamination at the Georgetown Steam Plant Flume, Phase IV: SCL Work Order #84-9 (Raven Systems & Research, Inc., December 1984)
- Sampling to Test for PCB Contamination at the Georgetown Steam Plant Flume, Phase III: SCL Work Order #84-6 (Raven Systems & Research, Inc., January 1985)
- GTSP Soil Excavation and Sewerline Cleaning (AB Consulting, Inc., 1985)
- Testing: Georgetown Flume, Georgetown Steam Plant Ditch, Myrtle St. Property: SCL Work Order #87-5 (Raven Systems & Research, Inc., June 1987)
- PCB Testing at Shoreline Substation and the Georgetown Fuel Tank: SCL Work Order #87-9 (Raven Systems & Research, Inc., July 1987)
- Analysis of Historic Sampling Results from Georgetown Steam Plant and Environs: SCL Work Order #87-10 (Raven Systems & Research, Inc., January 1988)
- Georgetown Tank Sludge and Soil Testing: SCL Work Order #87-14 (Raven Systems & Research, Inc., February 1988)
- Core Testing of the Georgetown Steam Plant Soil Pile: SCL Work Order #88-7 (Raven Services Corporation, May 1988)
- Water Quality and Sediment Testing at the Georgetown Steam Plant Condenser Pit: SCL Work Order #87-12 (Raven Services Corporation, December 1988)
- Sediment Sampling of the Georgetown Flume: SCL Work Order #88-12 (Raven Services Corporation, December 1988)

[3] Department of Ecology – Toxics Cleanup Program, Integrated Site Information System, Confirmed and Suspected Contaminated Sites List, October 5, 2006.

- Excavated Soils Testing at the Georgetown Steam Plant: SCL Work Order #89-16 (Raven Services Corporation, January 1990)
- Soil and Groundwater Investigation, Fire Training Center – North Boeing Field, King County Airport (Landau Associates, Inc., October 1992)
- Preliminary Assessment (The Bridgewater Group, 2000)
- Phase II Environmental Site Assessment (The Bridgewater Group, 2002)
- Georgetown Steam Plant January 2006 Soil Sampling (Integral Consulting, Inc., June 2006)
- Interim Remedial Action Completion Report, Georgetown Steam Plant (Integral Consulting, Inc., August 2006)

Investigation results are summarized below, organized by potential pollutant source.

3.4.1 Power House Operations

In 1983, SCL tested transformers inside the power house and did not detect PCBs (Bridgewater Group 2000). Sediments in the condenser pit were tested in 1988, and no detectable levels of PCBs were found (Bridgewater Group 2000).

During a July 1990 site visit, staining was observed on concrete in several locations throughout the power house (the former ash room, south end of the boiler room, and beneath the transformers located on the first floor gallery) (Bridgewater Group 2000). The lateral extent of staining was limited, and there was no evidence of a significant release that could have reached the condenser pit.

During the 2002 Phase II Environmental Site Assessment (ESA) conducted by The Bridgewater Group, wipe samples were collected beneath electrical equipment on the first floor of the power house (including the transformers and potheads), electrical equipment on the fifth floor gallery, and beneath the bearing lube oil pump and tank. No PCBs were detected on the first floor of the power house. PCBs (Aroclor 1248) were detected in one of five wipe samples from beneath electrical equipment on the fourth floor gallery, at a concentration of 1.1 ug/100 cm^3. No visual evidence of migration of dielectric fluid from the fourth floor gallery or boiler room to soil outside the building or to the condenser pit was observed (Bridgewater Group 2002).

PCBs were detected in two wipe samples from visibly stained areas beneath two transformers located on the second floor of the GTSP, at the southeast end of the boiler room. Aroclor 1254 was detected at 9 ug/100 cm^3 and 3 ug/100 cm^3 in the two samples; Aroclor 1262 was detected in one sample at 2.2 ug/100 cm^3 (Bridgewater Group 2002).

PCBs were also detected in six wipe samples collected from the fuel transfer system (Bridgewater Group 2002). Concentrations ranged from 4.3 to 109 ug/100 cm^3 (detected Aroclors only). Aroclor 1248 and Aroclor 1260 made up the majority of the PCBs detected.

Wipe samples collected from the bearing oil system and fuel system also contained petroleum hydrocarbons and PAHs (fluorene, phenanthrene, fluoranthene, pyrene, benzo(a)anthracene, and benzo(a)pyrene).

During the 2002 Phase II Site Assessment, soil samples were collected near the former oil valve shed, and the location of the former coal conveyer system and stacks, now occupied by a scale model railroad used by museum visitors (Bridgewater Group 2002). PCBs were not detected near the former oil valve shed; however, soils from the vicinity of the scale model railroad (used by museum visitors) contained PCBs from 0.04 to 3.6 mg/kg (Bridgewater Group 2000). PAHs were detected in two of four samples near the former coal conveyer system; total carcinogenic PAH concentrations were 0.89 and 1.4 mg/kg in these samples (Bridgewater Group 2002). Cadmium, chromium, copper, lead, mercury, nickel, tin, and zinc were also detected; concentrations were below Washington State Model Toxics Control Act (MTCA) cleanup levels.

A sample was collected from the condenser pit in March 2005, as part of the SPU Source Control Program (SPU and King County 2005b). Zinc (1.13 mg/kg) exceeded the cleanup screening level (CSL); total petroleum hydrocarbons (TPH)-diesel (2,300 mg/kg) and motor oil (9,700 mg/kg) exceeded MTCA Method A cleanup levels. PCBs were detected at 3.74 mg/kg (43 mg/kg organic carbon [OC]).

3.4.2 Cooling Water Discharges

Sediments in the GTSP discharge tunnel, which extends from the GTSP to the open Georgetown flume, contained up to 2,500 mg/kg PCBs during sampling in 1984 (SCL 1985c). Because the floor of the tunnel is lower than the floor of the Flume, about 15 cubic yards of sediment had accumulated in this area. Four sediment traps were installed in the Flume during the fall of 1984 to prevent downstream migration and discharge of contamination. Contaminated sediments were removed in 1985 and the tunnel opening was permanently closed (SCL 1985c).

3.4.3 Fuel Storage

Bunker C fuel oil was stored in three underground 12,000-gallon steel oil tanks near the south corner of the power house, a 150,000-gallon steel oil tank located southwest of the power house, and an 800,000-gallon aboveground concrete oil storage tank located to the northeast of the building. In addition, a 700-gallon tank located at the southwest corner of the GTSP contained diesel fuel.

In 1980, SCL collected oil samples from the three steel USTs. Tanks 1, 2, and 3 contained 10, 7, and 20 mg/L PCBs, respectively. This material was pumped out prior to 1984 (Raven 1988). Soil samples collected at depths ranging from 0 to 15 inches and 120 to 126 inches did not contain PCBs above the detection limit of 1 mg/kg (Laucks 1980, as cited in (Bridgewater Group 2000)). The tanks were removed in 1989; no PCBs were detected in soils during the tank removal (SEA 2004). Oil and grease was detected in a 0 to 1.2-foot sample collected near the north feed oil UST at a concentration of 35,690 mg/kg. TPH in samples from the excavation ranged from 8.6 to 67,600 mg/kg (SEA 2004). Confirmation samples collected from the bottom of the UST excavation contained TPH at 10 to 2,460 mg/kg; there was no indication of free product (Bridgewater Group 2000). During the Phase II Site Assessment, soil samples were collected downgradient of this former tank location and analyzed for TPH. One sample was also analyzed for PAHs (Bridgewater Group 2002). Up to 4,200 mg/kg diesel-range TPH and 2,200 mg/kg oil-range TPH were detected. Total carcinogenic PAHs were detected at 3.0 mg/kg.

The large concrete oil storage tank northeast of the site contained Bunker C fuel oil until May 1987. During an Ecology inspection in 1978, this tank was observed to be leaking. Oil in this tank contained 3.4 mg/L PCBs (as Aroclor 1260). It was demolished in 1988; no PCBs were detected in soils excavated during the tank removal or in concrete samples (Bridgewater Group 2000). Oil and grease, PAHs, and petroleum hydrocarbons were detected at 3,600, 200, and 250 mg/kg, respectively, in one soil sample collected at a depth of 14 feet near this tank. Another sample in this area contained 60,000 mg/kg PAHs at a depth of 21 feet [Slip 4 SCAP]. Two soil samples were collected along the current northeast property line in locations expected to be downgradient of this tank during the Phase II Site Assessment (Bridgewater Group 2002). Samples were collected at 9 to 11 feet bgs, just above the water table, and were analyzed for TPH. No TPH was detected.

In a 1988 summary of site data, Raven concluded that the underground fuel storage tanks and concrete fuel tank are not likely to be sources of contamination to the flume (Raven 1988).

The 700-gallon diesel tank was removed in 1989. PCBs were detected at 13 mg/L in samples from this tank (4.3 mg/L Aroclor 1242, 8.7 mg/L Aroclor 1260). No PCBs were detected in soil during tank removal.

No information on sampling near the 150,000-gallon steel oil tank was identified (Bridgewater Group 2000). The tank was apparently removed prior to 1966 (Bridgewater Group 2000).

3.4.4 Boiler Feedwater Discharges

During a 1983 Metro inspection, GTSP personnel indicated that blowdown from the boiler room was piped via a ditch (the blowdown channel) to the low-lying area (METRO 1983). The boiler feedwater blowdown channel was sampled in August 1984 (Raven 1984b). PCB concentrations were less than 1.4 mg/kg PCBs (Raven 1984b).

In a 1988 summary of site data, Raven concluded that the boiler feedwater discharge to the blowdown channel is not likely to be a source of contamination to the flume (Raven 1988).

The blowdown ditch was again sampled during the 2002 Phase II ESA. Four soil samples were analyzed for TPH and metals. TPH was not detected; however, arsenic, cadmium, chromium, copper, lead, mercury, nickel, tin, and zinc were detected in one or more samples. Arsenic (6 mg/kg) was detected above the current MTCA Method A cleanup level of 0.67 mg/kg (Bridgewater Group 2002).

3.4.5 Boeing Fire Training Pit

Two fire training areas are associated with the GTSP. The North Boeing Field Fire Training Center (NBF-FTC) is located to the east of the GTSP on KCIA property, and is discussed in Section 5.1. A second area, identified as the Boeing Fire Training Pit, was located about 50 feet southeast of the GTSP power house, on SCL property (Figure 3). This area was used for fire training activities from 1967 to 1974.

A portion of the Boeing Fire Training Pit was located over the former Duwamish River oxbow that was filled when the river was straightened. The oxbow was reportedly filled with dredged materials (Bridgewater Group 2000). It is possible that releases from this area could have preferentially migrated toward the drainage ditch and low-lying area.

Composite samples from the drainage ditch collected in August 1984 contained less than 4 mg/kg PCBs. In 1985, in conjunction with excavation of the low-lying area (see below), a tarp was installed along the ditch (Raven 1988). In 1986/1987, SCL sampled the ditch; it contained 4 mg/kg PCBs (Raven 1988). A ditch sample collected on August 20, 1987, contained 5.9 mg/kg PCBs (Raven 1988).

Samples collected from the drainage ditch between 1984 and 1992 indicate that PCBs were present at concentrations to 15 mg/kg (primarily Aroclor 1254). Aroclor 1248 was also present during the 1985 cleanup of the low-lying area (see Section 3.4.6 below).

Six samples were collected from the area of the former Boeing Fire Training Pit during the 2002 Phase II ESA. Depths ranged from 1.5 to 6 feet bgs. Aroclor 1254 was detected in one sample at 0.058 mg/kg at a depth of 3 to 5 feet bgs. A variety of PAHs were also detected in two of the samples; total carcinogenic PAHs were present at 2.3 and 4.0 mg/kg.

Two samples were collected and analyzed for TPH along the current northeast property line of the GTSP, in locations expected to be downgradient of the former NBF-FTC. No TPH was detected in the samples, which were collected at 6 to 9.5 feet bgs, just above the water table (Bridgewater Group 2002).

3.4.6 Low-Lying Area

During a 1983 Metro inspection, GTSP personnel indicated that, in addition to blowdown from the boiler room (see Section 3.4.4 above), soot from the boilers was dumped in the vicinity of the low-lying area (METRO 1983). The Metro inspector postulated that since PCB-contaminated oil was burned at the GTSP, the soot could have contained PCBs, which reached the flume by overflowing from the pond to the nearby Boeing catch basins (METRO 1983).

Sampling in 1984 confirmed the presence of PCBs up to 50 mg/kg in soils in the low-lying area (SCL 1984b). In April 1984, PCB concentrations up to 500 mg/kg were detected in sediment composite surface cores collected from the low-lying area (referred to as the "pond" in early reports) by Shapiro & Associates (Raven 1988).

In August of 1984, surface sediment samples collected from this area by Raven for SCL generally contained less than 50 mg/kg PCBs, except for the southwestern-most sample, which showed 403 mg/kg PCBs (Raven 1984b). The oily sand in the center of the low-lying area, which was collected from a vertically composited core (2- to 6-inch depth), contained 1,662 mg/kg PCBs. These samples were approximately 60 percent Aroclor 1242 and 40 percent Aroclor 1254 (Raven 1984b).

Transects across the low-lying area were sampled in March 1985 (Raven 1985). Samples were collected from a berm at the northern edge of the former "pond" at depths ranging from 6 to 11 feet. These samples contained less than 1 mg/kg PCBs. One sample of the east side of the low-lying area (adjacent to the fence) contained 91,000 mg/kg PCBs at a depth of 1 foot, 6,800 mg/kg at 3 feet, and 7.7 mg/kg at 4 feet (Raven 1985). The western vertical section contained 200 to 300 mg/kg PCBs at a depth of 1 foot, and a hot spot was identified in the center of the pond at 16,000 mg/kg (1-foot depth). Detected PCBs were primarily Aroclor 1242 and 1254 (Raven 1985).

A multi-stage cleanup of soils in the low-lying area was conducted by AB Consulting for SCL in October/November 1985. An area of approximately 40 by 50 feet was excavated to a depth of 3 to 4 feet, with a goal of removing soil containing over 10 mg/kg PCBs. Subsequent sampling of the cleaned areas indicated that PCB concentrations were reduced to 11 mg/kg or less. Detected PCBs were primarily Aroclor 1254, except at the easternmost portion of the excavation where Aroclor 1248 was detected (AB Consulting, Inc. 1986).

In addition, AB Consulting drilled cores underneath the asphalt paved area southeast of the pond on King County property. Composite samples contained 190 and 220 mg/kg PCBs (Aroclor 1254) (AB Consulting, Inc. 1986).

A composite sample was collected from the low-lying area (now filled) in 1986/1987; this sample contained 15 mg/kg PCBs (Raven 1988). On August 20, 1987, Raven (SCL) sampled the former Boeing storm drain southwest of the low-lying area; it contained 132 mg/kg PCBs. Although not labeled in these early reports, this catch basin was located near the current CB-181B and CB-185.

Three soil samples from the low-lying area were collected at depths of 5 to 7.5 feet bgs during the 2002 Phase II Site Assessment (Bridgewater Group 2002), as well as from an area downgradient of the North Boeing Field Fire Training Center (NBF-FTC; see Section 5.1). Aroclor 1242 was detected in all three samples at concentrations from 0.06 to 6.9 mg/kg. Aroclor 1254 was detected in one sample at 1.1 mg/kg (Bridgewater Group 2002).

In November 2005, Boeing collected soil samples from the gaps in the retaining wall along the fenceline that runs northwest to southeast between the GTSP and NBF. The highest PCB concentration in these soil samples was 2,400 mg/kg (Bach 2005e). Additional soil samples from this area were collected by SCL in January 2006 from the locations where PCB concentrations were greater than 1 mg/kg during the November 2005 sampling event. Results showed PCBs in surface soil at concentrations from 0.09 to 58 mg/kg, except for sample location S-19, which contained 410 mg/kg PCBs. Results are shown in Figure 4 (SCL 2006). In subsurface soil, PCBs generally ranged from 0.7 to 63 mg/kg, except for sample location S-19, which contained 3,900 mg/kg PCBs (SCL 2006).

An interim soil cleanup action was conducted in May 2006 to minimize potential human exposure to PCBs (SCL 2006). A strip of contaminated soil along the property boundary was removed; the trench was lined with geotextile fabric and backfilled with clean material. The soil was disposed of as TSCA remediation waste at the Chemical Waste Management landfill in Arlington, Oregon. Samples collected at the base of the excavation indicate residual PCB contamination at concentrations ranging from 0.08 to 3,800 mg/kg (Figure 5).

At the time this report was written, SCL was in the process of developing a site characterization plan to delineate the extent of PCB contamination in this area (SCL 2006).

3.4.7 Other Potential Sources

3.4.7.1 Former Greely Substation

While the former location of the Greely Substation is not currently owned by the city of Seattle (the property was sold to King County in 1963), it was associated with Seattle City Light operations and therefore is discussed in this section.

No information is available regarding the types of electrical equipment that were in service or whether the equipment contained PCBs (Bridgewater Group 2000). However, given its location, migration of PCBs to the condenser pit or to the drainage ditch and low-lying area is considered unlikely. Aerial photographs do not indicate a well-defined stormwater pathway from the north side of the power house to the drainage ditch or low-lying area (Bridgewater Group 2000).

Six soil samples were collected from the former Greely substation area, which was located to the northeast of the power house, during the Phase II Site Assessment (Bridgewater Group 2002). Samples were collected adjacent to each of three concrete pads where electrical equipment was formerly located. PCBs were not detected (Bridgewater Group 2002).

3.4.7.2 Pesticide Application

A variety of pesticides were used at the site, including the Greely Substation and an area to the north of the site referred to as the "Greely Sod Farm" (Bridgewater Group 2000). However, DDT, DDE, and DDD, which were identified as contaminants of concern in Lower Duwamish Waterway sediments, were not used at the site.

3.5 Potential for Sediment Recontamination

Although low levels of PCBs have been detected in wipe sample from the GTSP Power House, and in soil samples near the Power House, fuel storage areas, and boiler blowdown ditch, these sources are not believed to be sources of PCBs to Slip 4 sediments. Although PCBs were detected in sediments that had accumulated in the GTSP discharge tunnel at concentrations to 2,500 mg/kg, the sediments were removed and the tunnel opening was sealed in 1985. The GTSP was not believed to be the source of the PCBs in the discharge tunnel. PCBs were not detected in soils at the former Greely substation in 2001. Neither the GTSP nor the Greely substation are believed to represent a potential source of sediment recontamination for Slip 4.

PCBs were detected in the former low-lying area at concentrations to 91,000 mg/kg. It is possible that the former Boeing Fire Training Pit and ditch may have transported contaminants to this area. Although soils were excavated from a 40- by 50-foot area to a depth of 3 to 4 feet in 1985, PCBs were detected in soils passing through gaps in the retaining wall between GTSP and NBF at this location in November 2005, at concentrations to 3,900 mg/kg. An interim remedial action was conducted in 2006 to reduce potential direct contact human health risks; however, PCBs remain in soil at concentrations to 3,800 mg/kg. The source of PCBs to this area has not been determined; SCL is currently preparing a work plan for additional site characterization in this area. This property is considered a potential source of sediment recontamination for Slip 4.

4.0 North Boeing Field

North Boeing Field is located at 7500 East Marginal Way S. The entire area within the 130-acre NBF site is developed. Land use at the site includes office and industrial buildings, aircraft parking, and related facilities. Automobile parking areas comprise approximately 36 acres, or 28 percent of the site area; flight line positions and taxiways comprise about 42 acres, or 33 percent of the site area (Boeing 1994c). Less than one percent of the site is pervious, including landscaped areas next to some buildings.

4.1 Current Operations

Activities at NBF are classified as SIC Code 3721, Aircraft. Primary activities at the site include aircraft finishing and testing; research and development of Boeing military and commercial aircraft; and support services. Aircraft finishing activities involve wet sanding, cleaning, and painting of airplanes. Testing of airplane parts, both assembled and unassembled, occurs throughout the site. Testing procedures include: stress testing of parts; pressurized testing of hydraulic parts; jet fuel testing; testing of aircraft water distribution and wastewater collection systems; and fire suppression system testing [34]. Research and development groups at NBF have separate specialized testing operations. Support operations include photographic laboratories, metalworking, woodworking, and a wastewater treatment plant.

There are approximately 80 buildings located on the NBF site. Table 1 presents a list of these buildings at NBF and their current uses; the major buildings are shown on Figure 6. Boeing's Propulsion Engineering Laboratory (PEL) area is located in the northern portion of the NBF site; Flight Test and Operations are located in the central portion of the site.

According to a November 16, 2005, letter from Boeing to Ecology (Boeing 2005b), the only known existing use of PCBs at NBF was that associated with the joint sealant materials (see discussion below). Oil within compressed air systems at NBF has been found to contain low concentrations of PCBs, and transformers at NBF may contain PCBs as a result of the possible previous use of PCB-containing oil. Oil in compressed air systems has been tested and found to contain PCBs at concentrations less than 50 mg/kg. (Transformers manufactured prior to 1978 are allowed to contain concentrations of PCBs up to 50 mg/kg.) Some older transformers containing PCBs may be present in portions of NBF (Boeing 2005b).

4.1.1 Current Permits

NBF operates under the following permits and authorizations:

- Industrial Stormwater General Permit (No. SO3-000226), expiring November 18, 2005 (Ecology 2000). The most recent renewal was not found in the files.
- King County Industrial Waste (KCIW) Permit No. 7594, expiring May 11, 2005. The most recent renewal was not found in the files.

- Resource Conservation and Recovery Act (RCRA) identification number WAD 980982037. NBF is a large quantity generator of hazardous waste.
- Air Operating Permit No. 21147 (covers NBF and Boeing Plant 2), expiring May 20, 2007.

In addition, Boeing previously operated under NPDES Permit No. WA-000086-8. In 1994, Boeing submitted a Form 2F to determine whether an individual stormwater permit is required at the facility. A letter from Boeing dated December 7, 1994, stated that all known sources of non-contact cooling water (NCCW) had been eliminated from the site (Boeing 1994k). An Ecology compliance inspection on January 24, 1995, indicated that permit cancellation is in order as a result of Boeing's elimination of all point source discharges to the stormwater system (Ecology 1995).

Under the Industrial Stormwater General Permit, annual dry weather inspections are performed to identify unpermitted non-stormwater discharges, such as domestic wastewater, NCCW, or process wastewater. Quarterly discharge visual inspections and discharge monitoring are performed to look for evidence of pollution in the storm drain system, and to ensure that best management practices (BMPs) are being implemented.

During a KCIW inspection on March 2, 2005, in support of renewal of Permit No. 7594, facility condition and housekeeping were judged to be very good to excellent at all areas observed (King County 2005b). The facility's compliance history was noted as "excellent" in a KCIW Company Fact Sheet dated March 25, 2005 (King County 2005b). NBF has consistently been awarded the KCIW "Gold Award."

The following types of wastewater are discharged to the sanitary sewer system: rinse water from coating (alodining) and paint stripping operations, airplane wash water, film processing rinse waters and treated solutions, rinse from aqueous degreaser, discharge from oil/water separator (OWS) cleaning, discharges from a carbon ultrafiltration system, and sweeper dump filtration system effluent [253, 254]. A pretreatment system includes metals reduction, pH neutralization, and carbon ultrafiltration.

Four discharge sites were identified in the most recent KCIW permit:

- Building 3-369 Paint Hanger
- Outdoor plane wash stalls
- Building 7-027 Aqueous Cleaner Building (scheduled to cease operations in mid-2005)
- Sweeper dump vault

Self-monitoring requirements include metals; pH; fats, oil, and grease (FOG); discharge volume; settleable solids; PCBs; and total toxic organics (TTO). A draft permit issued on March 25, 2005 allows the discharge of up to 26,225 gallons per day (gpd) of miscellaneous discharges including blowdown, fire suppression system testing, general maintenance water, jet propulsion testing water, ground water, and construction dewatering (King County 2005c). Additional monitoring is required for the PEL area (cadmium, chromium, copper, lead, nickel, zinc, benzene, toluene, and ethylbenzene) and groundwater/construction dewatering (same parameters), as well as any other parameter that Boeing has reason to believe might be present. Treated wastewater that may contain PCBs must also be tested prior to discharge. Some offsite water is approved for discharge: Building 2-122 laboratory and tankline wastewaters; Building 4-83 wastewater treatment plant wastewaters; and miscellaneous groundwater and mop water from Boeing Plant 2 and Developmental Center facilities (King County 2005c).

Ecology conducted a stormwater source control inspection at NBF on December 16, 2005.

4.1.2 Current Site Drainage

The layout of North Boeing Field's storm drain system is shown in Figure 7. The storm drain system serves a large geographical area, including non-Boeing industrial operations on the north and east sides of the airfield (Landau 1993a). Drainage patterns at NBF are generally defined by the slopes of paved areas, building locations, and the storm drainage system.

Storm drain system piping ranges in diameter from 4 to 48 inches, and includes over 400 catch basins and 400 manholes (Landau 1993b). The catch basins and manholes are both circular and rectangular structures of various size and age constructed of concrete. Some of the older structures have wooden or clay floors. The total length of the system is estimated at 7 to 8 miles, of which approximately 17 percent is greater than 24 inches in diameter (Landau 1993b); in addition, the system contains up to 16 OWSs and lift stations, as well as parking lot drainage ditches and roof drains from a number of buildings.

Most of the drainage flow for the NBF storm drain system is directed toward a 60-inch trunk line which passes under East Marginal Way and discharges into Slip 4 at KC Airport SD#3/PS-44 EOF (identified by Boeing as Outfall No. 1). This line drains an area of 166 acres of NBF and 171 acres offsite (Boeing 1994j). The offsite areas that discharge to the KC Airport SD#3/PS-44 EOF upstream of NBF include the Air National Guard buildings, the King County Airport Maintenance Shop, and parts of KCIA located west, north, and northeast of the GTSP.

A second trunk line, 24-inches in diameter, currently drains an area of about one acre on the north end of NBF (Ecology 2006). This line also passes under East Marginal Way and discharges into Slip 4 via the NBF Storm Drain (identified by Boeing as Outfall No. 2). A small segment of the drainage flow on the northern edge of the field is directed into the 72-inch I-5 Storm Drain, which also discharges to Slip 4. Another segment of the drainage flow in the southern portion of NBF is directed to a 48-inch trunk line, which discharges into the Duwamish Waterway south of Slip 4.

Prior to its discharge to Slip 4, the NBF storm drain system is directed through a lift station, operated by King County (Figure 7). The lift station (Building 3-395) was built in 1941, according to King County Airport maintenance engineers (Landau 1993a). According to the King County engineers, tidal backwash into the storm drain system above the lift station is not possible; however, this was not verified.

An inspection of the lift station by Landau Associates on September 2, 1992, obtained the following information (Landau 1993a): the pump system is activated when the surface of stormwater in the reservoir under the lift station rises to an elevation of 2.60 feet, National Geodetic Vertical Datum (NGVD). The pump system is deactivated when the water surface in the reservoir lowers to 1.35 feet NGVD. A comparison of the invert elevations at sampling locations to reservoir water elevations allows a determination of the approximate extent of water backup in the system. Invert elevations were determined in 1993 for manholes and catch basins, as well as sample locations from the April 1993 storm drain system PCB sampling effort (Landau 1993a).

A main storm drain line, which drained approximately 120 acres at the north end of the airport, was rerouted through the lift station in 1990, prior to construction of Building 3-380 (Landau 1993a). Prior to this date, the storm drain line discharged to Outfall No. 2, without passing through the lift station. Based on comparison of invert elevations in this line to tidal elevations in the Duwamish Waterway, Landau (1993) (Landau 1993a) concluded that tidal backwash may have occurred to a significant extent in this line prior to its rerouting through the lift station.

The four major storm drain lines currently located at NBF are shown in Figure 7. These are referred to in this report as the south lateral, central lateral #1, central lateral #2, and north lateral.

Boeing cleans storm drain catch basins annually (Boeing 2005b). Solids are removed by a vacuum truck with the application of rinse water. Other structures, such as OWSs, are cleaned less frequently. Recent cleanout of storm drain lines is discussed in Section 4.3.

4.1.3 Potential Industrial Pollutant Sources

Potential stormwater pollutant sources are identified in Boeing's NPDES Form 2F for North Boeing Field, prepared in 1994 (Boeing 1994j). To better characterize runoff from the site, seven sampling locations (in addition to Outfall No. 001) were selected, including three sampling sites to collect runoff from offsite sources and four sampling sites to collect runoff from areas representative of the major onsite industrial activities. Stormwater sampling at these locations in 1994 indicated the presence of volatile organic compounds (VOCs, particularly methylene chloride), phthalates, and PAHs (Boeing 1994j). Follow-up sampling for methylene chloride is described Section 4.3.

Additional information on stormwater pollutant sources is presented in the NBF Stormwater Pollution Prevention Plan [34], dated September 2001. An updated version of this document is reportedly in preparation, but was not available at the time the current report was prepared.

Processes that generate sanitary wastewater at NBF are shown in Figure 8 (Boeing 2004b). These and other industrial pollutant sources are described below.

4.1.3.1 Loading and Unloading

Except for bulk liquid material, there are several authorized areas for the loading and unloading of both hazardous and non-hazardous new materials. Spent hazardous and non-hazardous materials are shipped off site. Bulk liquid material is delivered by vendors directly to the holding tanks. Most of these areas represent a potential source of pollutants as there are only a few covered and permanently contained loading and unloading areas. Few reported spills have occurred in these areas [34].

4.1.3.2 Materials Storage and Management

There are 13 storage stations that contain hazardous or liquid chemical materials at NBF; these are located within the Outfall No. 001 drainage basin [34]. Outdoor materials storage areas (other than aboveground or underground tanks) are roofed and equipped with secondary containment. Tank storage areas comply with all regulatory requirements, including secondary containment and failsafe controls.

The Central Dangerous Waste Accumulation Area (CDWAA) is located in Building 3-313; this area is used for less than 90-day accumulation of dangerous waste from satellite areas within the plant. The CDWAA is roofed and the loading area is covered. Dangerous waste is segregated by waste type in separate dedicated accumulation cells. Floors in each cell are sloped to separate dead-end sumps. Floors have appropriate chemical-resistant coatings.

Container accumulation areas are located at Building 3-369 (Paint Hangar), Building 3-822 (Fuel Farm), Building 3-831 (Automotive Shop), and Building 7-027 (South Yard), as well as mobile carts located on the flight line service aprons. Container accumulation areas are roofed or have stormwater protection provided, such as berms or plastic tarps. Hazardous material storage areas have secondary containment with sufficient volume to contain 110 percent of the volume of the largest container, or 10 percent of all containers, whichever is greater.

Airplane and fuselage sections are temporarily stored within the drainage basin, including in service apron areas and adjacent to Building 3-369 (Paint Hangar).

There are 31 aboveground oil storage tanks at NBF (Figure 9) for storage of oily wastewater, reclaimable oil, jet fuel, waste fuel, diesel, Jet A, PS-300, and hydraulic oil. In addition, the 1994 NPDES Form 2F identifies five USTs: three (UBF-4, UBF-5, and UBF-6) are located at Building 3-353 and contain recycled jet fuel, aviation gasoline, and Jet A; one (UBF-40) is located at Building 3-832 (unleaded gasoline); and one (UBF-61) is located at the fueling station, Building 3-470 (unleaded gasoline). Additional oil storage units include fuel trucks, portable tanks, mobile tanks, and drums.

All of the aboveground waste storage tanks are provided with secondary containment and are inspected daily. These tanks are equipped with overfill alarms (visual and/or audible), interstitial detection systems, and most are electrically connected to the site emergency monitoring and control system. The rest of the tanks (underground and aboveground) are inspected weekly. The adjacent storm drains either have emergency shut-off valves or drain covers. The potential pollution risks associated with these operations are posed by vendors that deliver products to or remove wastes from these tanks and do not follow the instructions posted at the tanks for drain coverage, or leave the tanker unattended during operations.

Boeing employs a variety of materials management practices designed to minimize contact of these materials with stormwater (Boeing 1994j). These include the following:

- Industrial activities, such as engine component testing, aircraft painting, and research and development activities, take place inside buildings or within contained areas.
- Transportation personnel and hazardous waste operators are trained in procedures for proper handling and packaging of hazardous materials and hazardous waste, such as segregation of incompatible materials, compatible packaging materials, proper flammable materials storage, and labeling requirements.
- Underground storage tanks meet Ecology requirements per WAC 173-360.
- Container accumulation and material storage areas are roofed or have stormwater protection such as berms or plastic tarps. Hazardous materials storage areas have adequate secondary containment.
- Boeing has developed and implemented a Hazardous Waste Management Plan and a Spill Prevention, Control and Countermeasure (SPCC) Plan. All emergency response plans are consolidated into the North Boeing Field Comprehensive Contingency Plan and Quick Emergency Response Guide.
- All Boeing and Boeing-contracted personnel who handle, transport, monitor, or manage hazardous materials or hazardous waste on Boeing property are trained to ensure that management of hazardous waste and materials are conducted legally and safely.
- Contractors are required to conduct work and store materials and equipment in a manner to protect stormwater runoff as directed by the Hazardous Waste Management Plan.

4.1.3.3 Outdoor Manufacturing Processes

Outdoor manufacturing processes consist of fueling and defueling aircraft, deicing at the wash stall (C-13), and performing engine preflight and avionics testing. Minor processes consist of cosmetic work such as touch-up painting, chemical cleaning, and interior work. Potential pollutants from the outdoor manufacturing processes that are susceptible to stormwater runoff are fats, oils, grease, and organics.

4.1.3.4 Vehicle/Equipment Washing and Steam Cleaning

Aircraft deicing and large vehicle and equipment washing occur at the C-13 Wash Stall. The wash stall discharges to the sanitary sewer unless it is determined that the water would fail the King County Department of Natural Resources discharge standards.

In January 1990, Boeing requested permission from Ecology to discharge propylene glycol deicing fluid to the storm sewer system (Ecology 1990b). This request was denied, and Boeing was directed to discharge all deicing fluid runoff from NBF to the Metro sanitary sewer via the airplane wash stall (Ecology 1990c).

There is a protected wash area at Building 3-354, which is located adjacent to the automotive maintenance shop, for vehicle and equipment steam cleaning. The wastewater pumped into tank ABF-160 is regularly shipped to an approved hazardous waste facility for proper disposal.

A fuel truck maintenance and washing area is located on a specially constructed concrete pad at the south side of Building 3-822. The water passes through an OWS before discharging into the sanitary sewer.

4.1.3.5 Onsite Treatment, Storage, and Disposal

NBF has a wastewater pretreatment system, located in Building 3-369, that is used to treat process wastewaters and other treatable hazardous waste. Stormwater drainage from the treatment plant, including the loading area, is processed through the treatment plant and discharged to the sanitary sewer.

A loading/unloading area associated with Building 3-369, Wastewater Treatment Plant, is used to transfer wastewaters from the site vacuum truck into the treatment tanks (Boeing 1997); a secondary use of this area is for loading of trucks with sludge for shipment off site. This area drains to a sump which contains a submersible pump that discharges the accumulated precipitation and potential spills to the stormwater system. A May 29, 1997, letter from Ecology to Boeing indicated that Boeing was to collect samples of this discharge to demonstrate that handling of sludge, vacuum truck wastewater, ferrous sulfate, lime, and polymer will not deteriorate stormwater (Ecology 1997). No sample results were found in the files.

4.1.3.6 Surface Runoff from Paved Surfaces

Boeing conducts regular (i.e., daily) sweeping at the NBF flight line, on both first and second shifts. No sweeping is conducted on a stall that is occupied; however, each stall is swept at least once per week. Sweeping is also conducted in response to a call to the dispatcher, such as after a plane has been pulled out of a stall if another plane is scheduled to occupy that stall (Keller 2006b).

The sweeping waste is collected and managed as follows (Keller 2006a,b):

- Water is separated from the solid material; the water is treated and discharged in accordance with Boeing's industrial wastewater permit from King County Department of Natural Resources and Parks.
- Solids are placed in roll-off containers and disposed of as appropriate.

Boeing shipped four roll-off containers of sweeping waste in 2005, averaging approximately 11 tons each (Keller 2006b). This material has been sampled for waste characterization purposes. The most recent sample was in December 2005; PCBs were detected in the sweeping waste at a concentration of 2.5 mg/kg (Keller 2006a).

4.1.3.7 Other Sources

Fertilizers, herbicides, and insecticides are utilized at NBF (Boeing 1994j). Lawn areas, plants, shrubs, trees, and planter boxes are fertilized several times per year. Herbicides are applied for weed control to lawn areas, planting beds, and trees in lawn areas. Insecticides are applied to trees and shrubs in landscaped areas around buildings and adjacent to East Marginal Way. A variety of chemicals may be used for these purposes.

A 1954 NBF drawing identifies a transformer at a location southeast of Building 3-301 (Bach 2006g). No additional information on this transformer is available.

4.2 Historical Operations

Boeing operations have been in place at NBF since the 1940s; however, little information on historical operations prior to the 1970s was found. Numerous structures have been built and demolished over the years, making it difficult to track historical operations in any detail. Information available in the files is summarized below.

4.2.1 Site History

The wooden flume was re-routed to its current configuration (where the two concrete pipe sections are located) sometime around 1953, to allow for the construction of Buildings 3-318 and 3-319. These buildings were demolished and replaced with existing Building 3-333 in 1996 (Bach 2006b).

1970s

- A Water Pollution Control Commission (WPCC) inspection on April 19, 1970, identified several problems associated with the complicated storm, sanitary, and combined sewer systems [34]. Specifically, the inspector was concerned with contaminated discharge to the storm sewer from airplane wash-down on the apron wash areas, located next to the blast fence and the Commercial Delivery Center apron. He recommended diversion of flow from the catch basins in these two areas to the sanitary sewer during washing events. He also recommended regular inspection of OWSs and detention tanks, designation of specific areas for handling and storage of chemical compounds and solvents with collection of drainage from these areas in a no-outlet sump, and other general improvements in housekeeping to prevent discharge of pollutants to the ground surface or the storm sewer system.
- At this time, the facility was using approximately 135 gallons of mixed solvents (isopropyl alcohol, methyl ethyl ketone, normal butyl alcohol, and toluene) per day to strip and clean planes for painting in the Paint Hangar (Building 3-369). About 20 percent of this solvent mixture was being washed to the sanitary sewer with the wash water [34].

1980s

- PCBs were detected in the Georgetown flume and NBF storm drain, which is tributary to the flume in the early 1980s.

- In a letter from Boeing Commercial Airplane Company to Metro, dated April 25, 1983, Boeing asserted that an investigation of Boeing Company activities had been conducted to identify potential sources of PCBs to the Georgetown Flume (Boeing 1983). No sources were identified. According to the letter, there had been nine PCB transformers in use at the site in the past; these were removed from service and disposed of to licensed hazardous waste disposal contractors in 1979 and 1980. Boeing found no records of leakage from these units. In addition, a piece of test equipment that contained 30 gallons of PCBs were stored at NBF; this equipment was also removed and disposed of in 1979 (Boeing 1983). No leaks were evident at the time of disposal, and no record or evidence of spills from this unit were identified. PCBs were never used as a hydraulic fluid in Boeing commercial or military airplanes, and no other known or suggested sources of PCBs were present. The letter also indicated that Boeing discharges NCCW from air compressors to the flume (Boeing 1983). In addition, some surface runoff drains from NBF to the flume.

- In August 1984, EPA identified NBF as a potential hazardous waste site based on sampling of storm drains conducted by Metro in 1982. Storm drains at NBF and in sediments from the Seattle City Light flume, which crosses the property, contained high levels of PCBs (USEPA 1984). Sampling by Boeing in May 1984 confirmed PCB contamination; however, it was postulated that the GTSP and flume are the source. An unlined fire pit where fuel is burned was also identified as a potential source of contamination.

- In 1984, Boeing proposed to clean the PCB-contaminated storm drain, which is tributary to the Georgetown Flume. Permission was requested by Boeing to discharge pre-treatment cleanup water to the sanitary sewer (METRO 1984b).

- The NBF facility apparently had been issued a METRO discharge permit (No. 7180) sometime prior to April 1985 (Boeing 1985).

- On April 23, 1985, Boeing applied for an NPDES stormwater discharge permit for the NBF site (Boeing 1985) for point source discharges (rooftop drains, street and parking areas, and paved airport areas). Approximately 93 percent of the 148-acre site was identified as paved. The application indicated that there are multiple points of NBF discharge to stormwater systems and the Georgetown flume (Boeing 1985).

- A letter from Metro to Boeing, dated November 14, 1985, described sewer connections associated with two OWSs at NBF. At the request of SCL, a dye test was performed on November 6, 1985, in the vicinity of an OWS near Building 3-404, which was suspected of containing PCB oil. Metro inspectors found that a sanitary sewer manhole located 15 feet due south from the Building 3-404 OWS flowed into the separator, which is normally connected to the stormwater system (METRO 1985c). This cross connection would result in sanitary sewage discharges to Slip 4. At the time of the inspection, the Building 3-404 OWS discharged to the Building 3-302 OWS, which had been dug up, the discharge line to the flume had been blocked off, and a temporary surface line to a sanitary manhole on the west side of Building 3-323 had been installed (METRO 1985c). This diversion had been implemented to facilitate cleaning of the Georgetown flume.

- During the same inspection, Metro observed an unbermed 10,000-gallon tank of methylene chloride at the northeast corner of Building 3-318, within 20 feet of the Georgetown flume (METRO 1985c).
- A letter from Ecology to Boeing dated July 28, 1987, indicated that modifications to the Industrial Wastewater Treatment Plant (Building 3-369) were nearing completion, and that Boeing intended to begin discharge to the METRO sewer system on August 1, 1987 (Ecology 1987b).
- On June 15, 1988, Boeing submitted an application for renewal of NPDES Permit No. WA-000086-8 (Boeing 1988a) for NCCW and stormwater runoff at the site. Boeing indicated in the cover letter that they no longer discharge stormwater to the Georgetown Flume; all runoff from NBF now enters Slip 4 through the King County lift station or the 24-inch Outfall 002 (Boeing 1988a). During its review of the draft permit, the Washington Department of Natural Resources (WDNR) expressed concern that stormwater and other sources of contaminated sediments will be released to state-owned aquatic lands without elimination or significant reduction in the quantity of those sediments prior to discharge (Boeing 2001).
- On March 10, 1989, Ecology conducted an inspection of the NBF site. Operations were satisfactory and in compliance with permit conditions (WA-000086-8). The inspector, Pam Elardo, identified apparent discrepancies in Boeing's permit renewal application (Ecology 1989a). According to the permit application, Outfall 001 receives storm and cooling water and is sampled at the catchment basin adjacent to the King County Lift Station; Outfall 002 receives only stormwater. However, recent construction rerouted 002 stormwater to the lift station, thus leaving that outfall dry. The inspection report referred to past problems with low pH, high pH, and temperature. Apparently, the temperature issues were related to water stagnating in the Georgetown flume in the summertime before discharge. Other observations during the inspection included: (1) a visible sheen and some surface foaming at the King County lift station (the permit renewal application indicates a maximum oil and grease of 30 mg/L, above the standard 15 mg/L limitation); (2) the facility has an excellent spill prevention and contingency program (Ecology 1989a); (3) An inside drain at Famco, a potential offsite source, appears to drain to the sanitary sewer, but this could not be confirmed; and (4) KCIA, another potential offsite source, has several OWSs, which serve as spill protection.
- Permit No. WA-000086-8 was reissued on December 8, 1989, for the discharge of NCCW and stormwater runoff to the Duwamish River, with an expiration date of December 7, 1994 (Ecology 1989d). The permit contained effluent limitations for flow of 350,000 gpd monthly average and 500,000 gpd daily maximum flows (Ecology 1995). The permit also required a complete inventory of cooling water discharges and an investigation of options for reduction, reuse, recycle, and elimination.

1990s

- A METRO discharge permit (No. 7594) was issued to Boeing Commercial Airplanes-North Boeing Field on May 11, 1990, for discharges associated with aircraft finishing, research and development, and testing and support operations (METRO 1990a). Types of waste generated included heavy metals, phenol, and toxic VOCs from airplane painting and stripping operations, photo processing, and airplane washing. The discharge volume at that time was 57,160 gpd.

- Boeing conducted a study in 1990 to identify sources of NCCW discharging to the storm sewer at NBF, which may be reasonably converted to closed-loop systems (Boeing 1990b). The study identified a total of 479,210 gpd that will no longer discharge to the storm sewer, or approximately 94 percent of the existing sources.
- In August 1992, Ecology ranked the NBF site using its WARM ranking matrix. The facility was given an overall score of "5," which is the lowest priority category (Ecology 1992b). This ranking was based on the following considerations:
  - Boeing has made a concerted effort to clean up contaminants on the site; several cleanup programs have taken place or are in progress. Lead and PCBs have been removed from the accessible parts of the site (Fire Training Facility and storm drains). The lead and PCBs that remain are not available to human or environmental routes since they are located beneath buildings and other inaccessible areas.
  - Most of the diesel spills have been addressed; petroleum contamination of groundwater is being addressed. The surface water route was not scored because "Boeing has cleaned up the contamination associated with the storm drains, the Fire Training Facility, and other surface spills." Most of the site is paved, asphalted, and covered with buildings.
- On September 28, 1992, Boeing submitted a Notice of Intent (NOI) for acceptance of Ecology's Baseline General Permit to discharge stormwater associated with industrial activity at NBF (Boeing 1992i). KCIA, as the property owner, elected to become a co-permittee for the facility permit. Coverage under the Storm Water Baseline General Permit was issued by Ecology on November 18, 1992 (Permit No. SO3-000226, expiring November 18, 1995) (Ecology 1992d).
- In March 1993, a cooling tower located in the Power Plant Test Center was put into operation (Boeing 1994b). As a result of the installation, the amount of NCCW was significantly reduced and the discharge of NCCW to the Duwamish River was less than 100,000 gpd.
- On April 21, 1993, Boeing was granted authorization to discharge groundwater to the sanitary sewer during construction at NBF. This approval was extended through October 31, 1993 (METRO 1993).
- A survey of stormwater discharges was conducted in the spring of 1994 (Ecology 1995). Massive reductions in cooling water discharge were accomplished through the installation of a cooling tower for the propulsion laboratory. This cooling tower services the cooling needs for numerous pieces of equipment including vacuum pumps, compressors, and steam generation systems. By late 1994, the cooling water flow was reduced to less than 40,000 gpd.
- Many small intermittent cooling water sources have been diverted to the Metro sanitary sewer and are covered under the facility's Metro permit. The discharge of steam

condensate wastewater was discovered as part of the March 1994 stormwater survey (Ecology 1995). These sources have been eliminated. Vacuum pump seal water sources were also discovered during the survey and have since been replumbed to recirculation systems. As a result of these efforts, NBF achieved zero discharge as of November 1994 (Ecology 1995).

- Discharge monitoring reports for July through September 1994 indicated two out-of-limit benzene, toluene, ethylbenzene, and xylenes (BTEX) conditions at Outfall 001 (Boeing 1994i).
- In August 1994, Ecology revised its WARM ranking matrix; as a result, the NBF site was re-ranked; however, it was still identified as a rank of "5," which is the lowest priority category. This ranking was a result of the presence of TPH and arsenic in groundwater, and the potential that PCBs and lead remain in inaccessible site soils (Ecology 1994c).
- Boeing's individual NPDES permit (No. WA-000086-8) was set to expire on December 7, 1994 (Boeing 1994c). Because Boeing planned to eliminate all NCCW discharges at the site by December 1994, they decided not to request renewal of this permit. Stormwater discharges would continue to be covered under the facility's baseline general permit for stormwater. Ecology indicated that completion of a Form 2F would be required to determine whether an individual stormwater permit was required for the facility, and whether to terminate or renew this permit (Boeing 1994c). To support preparation of the Form 2F, Boeing collected stormwater samples to characterize the waters generated by Boeing (Boeing 1994c) and selected to be representative of the major activities occurring at NBF.
- VOCs, including BTEX, methyl ethyl ketone (MEK), methylene chloride, chloroform, and/or trichloroethene (TCE) were detected in the flow-weighted composite samples from several of the sampled outfalls:
    - Outfall No. 1: What leaves the site and enters Slip 4; includes stormwater contributions from all sources within the NBF boundaries north of the aircraft wash stall, and includes four major offsite drainage pipes
    - Offsite No. 2: Offsite contributions including clear zone areas at the northern end of the airport, north of the ends of the runways, and southwest, south, and southeast of the Zellerbach Paper Building, and the T-hangars located adjacent to East Perimeter Road
    - Offsite No. 3: Offsite drainage, including the runways, east taxiway areas and loading aprons, and terminal, north annex, and administration buildings
    - Power Plant Test Center/Propulsion Lab: Located in the northeastern section of NBF; includes contributions from Offsite #1, which includes Seattle City Light and other upstream offsite drainage basins; methylene chloride detected at 6.5 ug/L
    - CDWAA: Located just south of the Power Plant Test Center
    - Aircraft Delivery: Encompassing a large section of the NBF site including Concourses A, B, and C and the Building 3-390 Flight Test Center

  Phthalates and phenols were detected in several of the outfall samples as well:

- Outfall No. 1 (BEHP – 3.1 ug/L)
- Offsite #1 (BEHP – 5.5 ug/L; di-n-octylphthalate – 1.0 ug/L)
- Offsite #2 (BEHP – 1.0 ug/L)
- CDWAA (BEHP – 1.8 ug/L)
- Aircraft Delivery (BEHP – 2.6 ug/L) (Boeing 1994j)

PAHs were detected in Offsite #3 (Boeing 1994j).

- A letter from Boeing dated December 7, 1994, stated that all known sources of NCCW had been eliminated from the site (Boeing 1994k). These sources were either connected to a recirculating loop, or for the smaller intermittent sources, diverted to the Metro sewer. A compliance inspection on January 24, 1995, indicated that permit cancellation is in order as a result of elimination of all point source discharges (Ecology 1995). The facility will continue to operate under the baseline general permit for stormwater, and has an ongoing stormwater pollution prevention program (SWPPP).

- Metro discharge permit No. 7594 was renewed on May 10, 1995. At that time, discharges were characterized as rinse waters from coating (alodining) and paint stripping operations; airplane washing and de-icing water; film processing rinse waters and treated solutions; rinse from aqueous degreaser; discharge from OWS; wash water from pavement cleaning; and waters generated from miscellaneous activities [158, 159]. Permitted discharges included 50,000 gpd categorical discharges, 88,310 gpd noncategorical discharges, 33,650 gpd NCCW, and 150,000 gpd sanitary wastewater, for a total discharge of 271,960 gpd.

- According to the permit application, NCCW discharges had been reduced over the past several years, from 54,800 gpd to approximately 33,650 gpd. The initial volume was actually higher because, as Boeing inventoried its discharges, it discovered that several sources of NCCW were being discharged into the storm drain system that had previously been unaccounted for (METRO 1994). Metro gave the company permission to re-route these discharges to the sewer.

- Discharges to the storm drain system, as of 1995, included: site irrigation water (5,246 gpd), fire protection system water (825 gpd), and stormwater (3,240 gpd).

- On May 17, 1995, Boeing submitted a request for renewal of coverage under the Industrial General Stormwater Permit No. SO3-000226 (Boeing 1995d). Coverage was renewed by Ecology effective December 18, 1995 (Ecology 1996a), expiring November 18, 2000.

- A Notice of Violation for pH at North Boeing Field was issued by the King County Water Pollution Control Division (formerly Metro) on July 18, 1996. This Notice was rescinded on August 22, 1996, due to concerns over the accuracy of the pH meter used by King County (King County 1996).

2000s

- On May 8, 2000, Boeing submitted a request for renewal of the North Boeing Field Industrial Stormwater Permit, No. SO3-000226 (Boeing 2000). A new permit was issued by Ecology on November 18, 2000 (Ecology 2000), expiring November 18, 2005.

- The most recent application for renewal of the Wastewater Discharge Permit for NBF is dated November 2004 (Boeing 2004b).
- A dry weather inspection was conducted on May 24, 2005, to confirm that all NCCW discharges had been eliminated (Boeing 1995e). During this inspection, a stray discharge was observed near Building 3-325; Boeing determined that the source of water is from the subsurface and is entering the stormwater line through a crack in the pipe. Analytical data reportedly indicate that the source is tap water, possibly from the aging Fire Protection lines that parallel the stormwater lines for several hundred feet (Boeing 1995e).

Discharges to Georgetown Flume

In 1952, The Boeing Company leased property from SCL, including areas adjacent to the Georgetown flume. A facility drawing indicates that an oil-filled sump and transformers were present on the property (Bach 2006g). Boeing constructed buildings in the leased area, including a fuel laboratory.

A portion of the flume was rerouted prior to construction of Building 3-333 [20, 115]. Storage tanks for fuel and other materials were installed, as well as storm drains and water pipes (SEA 2004). A 1954 site drawing identifies transformers located west of what is now Building 3-333 and north of Building 3-324, immediately adjacent to the buried concrete flume. These are listed as "to be removed by others"; it is not known whether these transformers contained PCBs.

In 1954, the City of Seattle allowed Boeing to connect a catch basin to a 24-inch City of Seattle sewer line located west of the steam plant building (Bridgewater Group 2000).

Reportedly, Boeing had two NPDES permitted discharges into the flume; these permits were cancelled and Boeing re-routed the discharges (Cargill 2004).

4.2.2 History of Spills

According to EPA's Toxics Release Inventory (TRI) database[4], non-production releases of chemicals at NBF have included glycol ethers (695 pounds, 1992 and 1996); methyl ethyl ketone (18 pounds, 1991 and 1992), naphthalene (73 pounds, 1991 through 2000), and toluene (8 pounds, 1992). A discharge of Freon 113, MEK, toluene, and xylenes (5 pounds each) to the Duwamish River in 1990 is also listed in the database.

No information on spills prior to 1985 was found. A summary of release reports and correspondence is provided below.

August 9, 1985: Employees of FAMCO Transport Incorporated were observed dumping 55-gallon steel drums of an oil product through a Boeing property fence and into a storm drain on Boeing property (Boeing 1986b). Boeing personnel notified EPA and Ecology, and contacted an environmental cleanup contractor to respond immediately and pump out the storm sewer. Subsequent testing of the drain system by FAMCO's consultant indicated the presence of PCBs,

[4] EPA Envirofacts Warehouse: http://iaspub.epa.gov/enviro

heavily enveloped in solvent, in Manhole SD-A18-MH. This investigation is described further in Section 4.3.

March 25, 1986: Approximately 20 gallons of paint hangar wash water were spilled outside the treatment plant (Building 3-369), as a result of a valve failure. Ten to 15 gallons of the spilled water were contained on site; 5 to 10 gallons spilled to the storm drain. A sample of the tanks from which the leak occurred indicated low levels of chromium, lead, and zinc, and TTO of 3.5 mg/L (Boeing 1986c).

May 30, 1986: A compressor oil seal failure caused an unknown quantity (up to 10 gallons) of oil to spill to the Georgetown Flume (Boeing 1986e). Booms and absorbent pads were deployed in the flume and Slip 4.

December 17, 1987: Approximately 1 gallon of mineral oil was spilled into a storm drain near the east side of Building 3-962 by a contractor working on the chiller (Ecology 1987c).

June 9, 1988: Uncured asphalt emulsion roofing material was washed off the roof of Building 3-370 during a rainstorm. Some of the runoff entered the storm sewer. The runoff had a pH of 6.0 and oil and grease concentration of 45,500 mg/L. No sheen was detected at Slip 4. No estimate of the volume of contaminated water was made.

January 2, 1990: A sanitary sewer overflow from the lift station near Building 3-417 flowed into a nearby stormwater catch basin for approximately 15 minutes (Ecology 1990a). The overflow did not contain industrial waste.

November 23, 1991: Approximately 100 gallons of water with 3 to 6 percent aqueous fire fighting foam (AFFF) FC-783 synthetic firefighting foam were discharged to a nearby storm drain during testing of the sprinkler system at Building 3-380 (Paint Hangar) (Boeing 1991c). The spill occurred due to an unblocked drain pipe from the building. The discharge was immediately diverted to the sanitary sewer and the escape drain was plugged. Samples were taken from two downstream catch basins, which indicated that foaming was not occurring.

December 12, 1991: Less than 30 gallons of Jet A Fuel were released from the G Slab area as a result of tank tightness testing (Boeing 1994j). The spill was reported to Ecology.

December 18, 1991: Approximately 50 gallons of AFFF (3 percent) were released at the Power Plant Test Center Fuel Test Slab during fire system testing (Boeing 1994j).

January 30, 1992: Fuel was detected at the King County Lift Station (Building 3-395) after a heavy rainstorm; the fuel was traced to recent additions to the OWS piping at the Aviation Fuel Farm (Boeing 1992b). Installation of a utility trench at the Fuel Farm required a reroute of the storm lines in the area; an overflow line set in a pre-cast concrete plate was installed near MH-1A to accommodate 100-year storm flows. Upon inspection, Boeing determined that the overflow plate had been improperly sealed, allowing stormwater to flow around the edges of the plate and bypass the OWS. The plate was resealed on February 7, 1992. The duration of the bypass is not clear.

April 13, 1992: Eight to 100 gallons of soapy water were improperly discharged to the storm sewer at Building 3-380 by a contractor; the job was halted until able to discharge to sanitary sewer (Boeing 1994j).

April 16, 1992: Less than 100 gallons of paint wash water were released at Building 3-369 when an overfill switch failed (Boeing 1994j). The spill was reported to Ecology.

April 16, 1992: Up to 400 gallons of wastewater were spilled to a bermed containment area when a tank at the wastewater treatment plant overflowed and the shut off valve malfunctioned. Up to 100 gallons were released to the storm drain (Ecology 1992a).

March 1, 1993: About 2,000 gallons of hot water were discharged to the storm sewer at Building 3-380 during HVAC maintenance (Boeing 1994j). The spill was reported to Ecology. Two samples were obtained, one at the discharge point into the storm sewer and another at the King County lift station. All data were within permit limits (Boeing 1993b).

March 3, 1993: About 1,000 gallons of hot water were released to the storm sewer at Building 3-380 when a steam valve failed on a process hot water tank (Boeing 1994j). The spill was reported to Ecology. Samples obtained at the storm drain just outside Building 3-380 indicated water quality within permit limits except for copper, which was present at 0.14 mg/L (Boeing 1993c). No samples were collected at Outfall 2.

February 7, 1994: During an inspection of the NBF storm sewer system, a flow of oily water was observed in a manhole located on the opposite side of the blast fence near the A6 stall on the flightline (Boeing 1994a). This point represents the location of influent waters from businesses located on the northeast side of the Airport. According to KCIA personnel, a malfunction/misoperation of an OWS on the KCIA site was the cause, and the situation was corrected. A sample of water near the A6 stall and at the King County lift station were collected and analyzed for metals and FOG. Results indicated that the influent water contained 35 mg/L FOG and the water discharged through the lift station contained 2.6 mg/L FOG (within NPDES discharge limit of 15 mg/L). The manhole and lift station were resampled on February 16, and FOG concentrations were 3.3 and 2 mg/L, respectively.

June 15, 1994: A letter dated June 17, 1994, from Boeing to Ecology described the discovery on June 15 that the Rain Erosion Test Facility, located in the Power Plant Test Center adjacent to Building 3-321, discharges process water to the storm sewer system (Boeing 1994f). In this process, water is sprayed onto a coated test panel to accelerate the erosion process; this water is discharged directly to the storm sewer. The facility has operated for at least 15 years; operating records since 1991 indicate intermittent usage with a total discharge of 23,400 gallons of water. The amount of primer, consisting of 15 percent strontium chormate, discharged to the storm sewer during that period was calculated to be 0.016 pounds (Boeing 1994f). This discharge was diverted to the sanitary sewer system.

July 13, 1994: Approximately 20 gallons of wash water were discharged to the storm sewer system on the southeast side of Building 3-369 (Boeing 1994g). This material escaped from the building while personnel were washing down the floor of the paint hangar and left a door to the outside open. The wash water is typically collected in the building trenches and pumped to the wastewater treatment plant. The discharged water contained small amounts of metals (cadmium, chromium, copper, lead, nickel, zinc) and organics (methyl ethyl ketone, 15.6 ug/L; 1,1,1-TCA, 1.2 ug/L; chloroform, 1.0 ug/L; benzene and toluene <1 ug/L) (Boeing 1994g). Water remaining in the catch basin was vacuumed out and the catch basin was cleaned.

July 20, 1994: Between 100 and 500 gallons of a 3 percent AFFF solution were spilled to the storm sewer system in the Power Plant Test Center at NBF, after the fire protection system at the fuel farm was activated by high ambient temperatures (100°F) (Boeing 1994h). Most of the solution was contained within the fuel farm retention tanks. However, one sprinkler head was misdirected outside of the containment area towards temporary plastic film used for painting operations. The discharge went directly into the storm sewer system. After the spill was reported, the Lift Station was taken out of service. A small amount was pumped into the river before the shutdown was completed. Booms were placed into the Duwamish at Slip 4 to prevent material from escaping into the Duwamish River. On July 21, the Lift Station was put back on line. Later that day, Slip 4 showed significant amounts of foam. Additional booms were placed in the water to contain the spilled material and the Lift Station was shut off. An environmental contractor was then hired by Boeing to clean out all the lines from the spill area to the lift station; this was completed on July 22.

February 3, 1996: Approximately 60 gallons of PS-300, a fuel oil, were spilled near Building 3-374 during unloading into an aboveground storage tank (AST), when a valve located at the tank was inadvertently left closed during the unloading operation (Boeing 1996a). Pressure on the hose when the pump started up caused the hose to fail. The tank and unloading area are within a contained area. PS-300 is a high viscosity petroleum distillate with very low flow characteristics. Cleanup efforts were immediately initiated and no product entered the storm sewer system.

February 6, 1996: A broken hose caused Bunker fuel oil to be sprayed on pavement (Ecology 1996b). The location of the spill was not documented; however, it was contained at a catch basin. Samples were collected and showed FOG at or near 2.5 mg/kg (0.5 mg/kg over the limit). No sheen was present. The pavement area was steam cleaned. No additional information on this spill was available.

January 29, 1998: A spill of waste oil/petroleum occurred near the north end of Building 3-313 (Ecology 1998a). Approximately 2 gallons of the material entered a storm drain during transfer of a drum from a waste cart to the central accumulation area.

April 30, 1998: During a subsurface investigation in support of proposed upgrades to the stormwater sewer system, a release of PCBs to soil in the vicinity of Building 3-326 was discovered (Boeing 1998b). This location was previously reported to Ecology following removal of underground storage tank UBF-55. According to Boeing, no known sources of PCBs were associated with Boeing activities; in addition, the location was adjacent to Seattle City Light's PCB soil remediation area (the low-lying area, as discussed above) (Boeing 1998b). No remedial actions were planned by Boeing.

January 17, 1999: Approximately ½ gallon of diesel fuel was spilled outside on the south side of Building 3-380, due to a leaking portable power generator (Boeing 1999). The material entered a storm drain that flows into the lift station. A sample of the wet well water at the lift station was collected and a trace amount of oil or sheen was observed. The Boeing Fire Department inspected the Slip 4 outfall and no visible residue of oil was observed.

June 11, 2004: A small amount of AFFF (foam) was discharged to Slip 4 from the annual test of the Building 3-333 Fuel Test Facility fire suppression system (Boeing 2004a). Foam was observed discharging to Slip 4 downgradient of NBF. The Fuel Test Facility fire suppression system combines AFFF and water to spray in the event of a fire. To conduct the annula test, the AFFF valve is shut and only water is used. However, typically there is a residual amount of dried AFFF that remains in the system from the last instance of foam spray that is washed out with the test. On June 11, instead of isolating the fire system test water in a retention tank, the water was discharged into the storm sewer through an OWS. However, residual AFFF mobilized from fire water sprayed as part of the test was not captured by the separator and made its way to site discharge. The Fuel Test Facility drainage system was cleaned to remove any residual foam.

4.3 Environmental Investigations and Cleanups

Numerous investigations and cleanups have been performed at NBF. Soil and groundwater investigations are summarized in Section 4.3.1; storm drain system sampling is described in Section 4.3.2. Finally, activities related to PCB-contaminated joint material removal are discussed in Section 4.3.3.

In 1989, Boeing removed and replaced three USTs: UBF-25, a steel 550-gallon gasoline tank; UBF-30, a steel 180-gallon diesel tank; and UBF-60, a concrete 5,000-gallon steam cleaning rinsate tank (Boeing 1989a). No soil sampling data associated with these tank removals were found in the files.

During 1991/1992, Boeing conducted an underground storage tank testing program (Boeing 1992a). Results are discussed by area below, as relevant.

Soil and groundwater investigation and remediation locations are shown on Figure 10.

4.3.1 Soil and Groundwater Investigations – Northern Portion of Site

4.3.1.1 Inlet Development Facility, Building 3-353 (1990)

In July 1990, a release of petroleum hydrocarbons occurred during excavation associated with construction of an Inlet Development Facility at NBF (Boeing 1990d). Eight soil samples were collected from a utility trench for jet fuel lines located near an electrical transformer, and an underground vault (GTI 1990b). Results indicated TPH concentrations of 30 to 77 mg/kg in the walls and bottom of the excavation, and 350 mg/kg in a pile of soil excavated from the vault area. One sample was analyzed for BTEX; these were not detected. None of the samples were analyzed for PCBs. Approximately 10 cubic yards of petroleum hydrocarbon-impacted soil were removed (Boeing 1990d).

4.3.1.2 Utilidor Project (1990)

In June 1990, petroleum-impacted soil was encountered during a linear excavation for a utilidor of approximately 1,000 feet and varying in depth from 6 to 8 feet. A ground penetrating radar (GPR) survey was conducted along the utilidor route; several suspect areas were identified, which could have been underlain by buried tanks (GTI 1990a).

Suspect soils encountered during utility relocation were stockpiled to the northeast of the Apron A blast fence; the pile was subsequently moved to the Building 3-380 construction area for aeration.

One area was underlain by a "French drain" or flume; the drain was filled with gravel and sludge, and the wooden sides were coated with tar (GTI 1990a). Tar, sludge, and surrounding soil were sampled and analyzed for TPH, PCBs, PAHs, and metals. Low levels of PAHs including phenanthrene, fluoranthene, pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, and benzo(a)pyrene were detected. Benzo(b)fluoranthene was detected in one sample at 0.17 mg/kg, which is above the current MTCA Method B cleanup level of 0.14 mg/kg. PCBs were not detected.

Another area contained six abandoned pipes, and a third area was underlain by a large concrete wall or foundation structure. Soils to the immediate east of the concrete appeared to contain hydrocarbons; this soil was stockpiled at the east end of the utilidor. Soil samples indicated the presence of TPH to 23,000 mg/kg.

Stockpile samples were analyzed for TPH; a subset of samples was analyzed for BTEX, PAHs, and PCBs. No PCBs were detected. Approximately 200 cubic yards of soil containing TPH above 200 mg/kg were disposed of (Boeing 1990c).

4.3.1.3 Buildings 3-360/361/365 (1991)

A pre-construction environmental investigation was conducted at this location in November 1991 (SEACOR 1992a). This site consists of approximately 1.8 acres of property encompassing Buildings 3-360, 3-361, and 3-365, and the employee parking lot north of Building 3-365. It is bounded by S. Willow Street to the north, S. Myrtle Street to the south, Occidental Avenue to the east, and Ellis Avenue S. to the west. The site is at an elevation of approximately 12 feet above MSL; topography is relatively level with a slight slope toward the west. Groundwater was encountered at depths from 7.5 to 11 feet bgs.

During the investigation, 14 soil and 4 groundwater samples were collected and submitted for chemical analysis. Soil borings were drilled to depths ranging from 7.5 to 20 feet. TPH, acetone, methylene chloride, and metals were detected in soil samples; none of the analytes exceeded their respective MTCA Method A soil cleanup levels. TPH, 1,2-dichloroethene, methylene chloride, tetrachloroethene, trichloroethene, copper, nickel, and zinc were detected in groundwater. TPH (1.0 to 4.6 mg/L) and trichloroethene (1,000 ug/L) were detected above the MTCA Method A groundwater cleanup levels (SEACOR 1992a). Trichloroethene was detected at a concentration 200 times greater than the cleanup level. PCBs were not detected; however, only three soil samples and two groundwater samples were analyzed for PCBs. In addition, the detection limit for PCBs in groundwater was 10 times higher than the MTCA Method A cleanup level.

4.3.1.4 Building 3-354 (1991-1992)

A potential release was identified during a pre-construction environmental exploration of a site for Proposed Building 3-354 (Boeing 1991b). The site is located on the north side of the Apron A blast fence in the Power Plant Test Area. Eight soil borings were drilled in October 1991, to depths of 5.5 to 7 feet. Samples were analyzed for TPH, VOCs, metals, and PCBs. TPH concentrations ranged from 10 to 560 mg/kg. VOCs were not detected. PCBs (Aroclor 1260) were detected in two samples (SB-1 at 0.3 mg/kg and SB-4 at 0.1 mg/kg) (GTI 1991a). Metals concentrations were low. TPH exceeded the MTCA Method A cleanup level (200 mg/kg) in three samples located around the perimeter of a concrete slab near the center of the proposed building (GTI 1991a). The area around these three samples was subsequently excavated (Boeing 1992e). Based on a sample of the excavated material, Boeing concluded that the earlier TPH results were inaccurately interpreted as a release, and were more likely the result of asphalt debris in the samples.

4.3.1.5 F&G Facility, Building 3-324 (1991 – 1994)

This facility is located in the northern portion of the NBF site at an elevation of approximately 5 feet above MSL. Eight jet fuel USTs, identified as UBF-10 through UBF-17, were located at this facility. UBF-10 through UBF-13 were situated side-by-side on the "F" slab at the south end of the facility; UBF-14 through UBF-17 were situated side-by-side on the "G" slab at the north end of the facility (SEACOR 1994a).

Two of four USTs at this location (UBF-14 and UBF-15) failed a leak test in late 1991. The tanks were emptied and groundwater in the vicinity was sampled; no contamination was detected (Boeing 1992c). The tanks were to be removed concurrent with a facility upgrade in 1994.

Seven monitoring wells (FG-5 through FG-11) were installed at the site in 1986 by Landau Associates; an additional well (FG-MW1), downgradient of FG-11, was installed by SEACOR in 1994. Quarterly groundwater monitoring and sampling in wells FG-5 through FG-11 began in December 1991; data indicate that TPH within the diesel range was detected at concentrations above the analytical method detection limit in wells FG-5 and FG-11 (SEACOR 1994a). Benzene was also detected in FG-11 at slightly above the method detection limit. TPH in diesel range exceeded the MTCA Method A cleanup level in four of nine quarterly sampling events between 1991 and 1993. Groundwater movement beneath the F&G Facility was generally to the west at a gradient of approximately 0.003 feet per foot.

A preclosure site assessment investigation was conducted by SEACOR at this site in November 1993 (SEACOR 1994a). Twenty nine soil samples were collected from 17 soil borings, ranging from 4 to 9 feet in depth. Petroleum hydrocarbon-impacted soil was identified at three locations within the deeper soils: on the east side of the investigation area; between the "F" and "G" slabs;

and on the south side of the "F" slab (south of UBF-13). The impacted soil between the slabs suggests that the gasoline and diesel range hydrocarbons detected in this area may be associated with the underground product pipeline located west of the borings (SEACOR 1994a). The petroleum hydrocarbons detected in soil south of UBF-13 were within the oil range. A groundwater sample collected from FG-MW1 did not indicate the presence of petroleum hydrocarbons at this location.

The eight USTs at this site were scheduled to be excavated and removed prior to the construction of a new office building (Building 3-324) at this location (SEACOR 1994a). The eight monitoring wells at this site location were decommissioned in April 1994 (SEACOR 1994c).

In May/June 1994, the eight USTs and associated piping were removed and approximately 375 cubic yards of soil were excavated. A total of 44 soil samples, including 37 samples from the excavation and 7 stockpile soil samples, were collected (SEACOR 1994c). Nineteen samples were collected from the "G" excavation area, 14 samples from the "F" excavation area, and 4 samples from the floor of the two product pipeline trench excavations. Samples were analyzed for TPH; stockpile soil samples were also analyzed for BTEX, Toxic Characteristic Leaching Procedure (TCLP) metals, and PCBs.

Analytical results from the final excavation limits indicated that all TPH-impacted soil had been excavated (SEACOR 1994c). In the stockpile samples, diesel range hydrocarbons were detected in one sample. BTEX were not detected.

PCBs were detected in four of the stockpile samples. Aroclor 1254 and Aroclor 1260 were detected at concentrations below the MTCA Method A soil cleanup level (SEACOR 1994c).

4.3.1.6 Green Hornet Area (1992–1994)

The Green Hornet Area tank farm was located near Buildings 3-311, 3-312, and 3-313, in the northern portion of NBF. The site was the location of three 12,000-gallon USTs (UBF-7, UBF-8, and UBF-9) associated with the Green Hornet Wind Tunnel Facility; they were used to store jet A fuel. The tanks, which were installed in 1950, failed a leak test in early 1992 (Boeing 1992f) and the fuel levels were immediately lowered to below the suspected leak area. On July 28, 1992, Boeing notified Ecology of their intent to permanently close the tanks (Boeing 1992f); the tanks were to be replaced with a single AST (Boeing 1992c).

These tanks were partially above and partially below the ground surface beneath a rectangular raised area, the surface of which was about 8 feet above the surrounding grade. The fueling facility at the Green Hornet Area was decommissioned in 1993; a site investigation conducted during the removal of the tanks found hydrocarbon-impacted soil (i.e., TPHd above MTCA Method A soil cleanup levels) in soil samples from the southern and western sidewalls and floor of the excavation (SEACOR 1994b). Floating non-aqueous phase liquid (NAPL) was observed in well GH-4 (SEACOR 1994b).

In September 1993, Boeing conducted an independent soil remedial action. Approximately 1,250 cubic yards of soil and a concrete OWS were removed from the vicinity of the former Green

Hornet tank farm [100]. Petroleum-impacted soil was removed to the extent feasible; however, impacted soil was not removed if existing structures would have been compromised, or where soil impacts were apparently related to the fluctuation of hydrocarbon-impacted groundwater. A visible hydrocarbon sheen was observed on groundwater (observed at approximately 5 feet bgs), which accumulated in the excavation (SEACOR 1994b). Groundwater was indicated to be towards the east at a gradient from 0.010 to 0.031 feet per foot.

Soil samples collected from the sides of the excavation detected the following chemicals above MTCA soil cleanup levels: petroleum hydrocarbons (TPHg, TPHd, total recoverable petroleum hydrocarbons), benzo(a)anthracene, chrysene, benzo(b)fluoranthene, and benzo(a)pyrene. Three samples were analyzed for PCBs, which were not detected. Analysis results show that TPH-impacted shallow soil remains on the southeast and south sides of the excavation perimeter. In addition, impacted deeper soils (i.e., > 4 feet bgs) remain on the northeast, east, and west excavation perimeters [100].

A supplemental site assessment investigation was conducted in November–December 1993 (SEACOR 1994b). Six monitoring well borings were installed, and soil and groundwater samples were collected. Soil samples from three of the borings contained petroleum hydrocarbons (TPHg and TPHd); one sample contained low levels of total xylenes. Samples from borings GH-MW2 and GH-MW3 contained TPHg and TPHd at concentrations above the MTCA Method A soil cleanup level (500 mg/kg and 1,600 mg/kg, respectively).

In groundwater, well GH-MW4 contained TPHg, total recoverable hydrocarbons, and total xylenes (3.2 mg/L, 8.8 mg/L, and 36 ug/L, respectively) above the MTCA groundwater cleanup level. Well GH-MW5 contained TPHd (5.0 mg/L) above the MTCA groundwater cleanup level. These wells are located to the east of the former Green Hornet tank farm. In contrast to the 1992/1993 groundwater monitoring, this investigation indicated groundwater flow is to the west-southwest at a gradient of approximately 0.001 feet per foot, and therefore the MTCA cleanup level exceedances are located upgradient of the site (SEACOR 1994b).

The investigation concluded that, although petroleum-impacted soil and groundwater are present at this location, their extent is limited, the area is paved with asphalt, and the area is not accessible to the general public, and therefore the site poses a low environmental risk (SEACOR 1994b). Groundwater monitoring for diesel-range hydrocarbons continued until at least 1998 (Boeing 1998c); results indicated continuing detections of TPHd in GH-MW4.

4.3.1.7 Fuel Test Facility (Building 3-333, formerly Buildings 3-318 and 3-319) (1991 – 1997)

A subsurface hydrocarbon recovery system began operation at this location on May 23, 1986 (Boeing 1987a). The system did not recover any free (floating) fuel product in the recovery well. Ecology granted permission to terminate the recovery program, but requested that monitoring of site conditions continue until December 1986 with testing of the well prior to closure. A groundwater sample collected January 1987 contained no detectable concentrations of BTEX (Boeing 1987a).

Low levels of methylene chloride were detected in the first flush grab sample and flow-weighted composite sample from the Power Plant Test Center, and in the flow-weighted composite sample from the main outfall collected on September 14, 1994 (Boeing 1994j). Methylene chloride was stored in a 10,000-gallon tank inside Building 3-318; this material was used as a coolant and was piped to a test pad located just south of the building. Boeing hypothesized that trace amounts of methylene chloride escaped into the storm sewer system during demolition of sections of this test pad between July and September 1994. An additional grab sample was collected during the first flush of a storm event on October 1, 1994; methylene chloride was detected at 19.5 ug/L (Boeing 1994j). The pad surface and sewer lines were subsequently pressure washed, the wash water isolated, collected, and disposed via the sanitary sewer.

Follow-up sampling was conducted during October 1994 through February 1995. Samples collected from Manhole 7-A (near Building 3-350) and Manhole 13-A (near Building 3-626) showed methylene chloride concentrations from 4.5 to 482 ug/L and 1.3 to 62.5 ug/L, respectively (Boeing 1995c). Low levels of toluene, ethylbenzene, 1,1,1-TCA, and 1,1-DCA were detected in some samples. Boeing conducted a thorough investigation of the site, which revealed no leaks or breech of integrity of the methylene chloride system. Although the storm lines have been cleaned, trace amounts of methylene chloride still remained (Ecology 1995).

During preparations for Phase I construction of Building 3-333 (e.g., the portion of the building parallel and immediately adjacent to the Georgetown flume), Boeing conducted an independent remedial action at this site. Preliminary and supplemental site investigations were conducted by SECOR in 1994 and 1995 to assess the extent of TPH and PCB in subsurface soil in the vicinity of an OWS at the southwest corner of the Fuel Test Slab, adjacent to the proposed location of Building 3-333. The Phase I construction replaced Buildings 3-318 and 3-319. The OWS collected stormwater runoff from the fuel test slab area (Boeing 1996b).

Twelve hand auger soil borings and 21 hollow-stem auger borings were drilled and sampled. In addition, one groundwater monitoring well was installed and sampled. Results indicated that soil within the remediation area exceeded the MTCA Method A soil cleanup standards for gasoline and diesel range hydrocarbons. The MTCA Method A soil cleanup level for PCBs was not exceeded in the Phase I construction area (SEACOR 1996b).

While the site investigation and supplemental site investigation reports were not available for this review, other documents indicate that the 1994 site investigation found PCBs (Aroclor 1254) in soil at concentrations up to 510 mg/kg, at location MW-1, 3.5 feet bgs (Boeing 1995b). *(Note: this concentration was reported elsewhere as 5,100 mg/kg).* TPH as gasoline and diesel were detected at concentrations up to 12,000 mg/kg at this same location (Boeing 1995b). Groundwater from this well exceeded the MTCA cleanup levels for TPH and PCBs. Two wood samples were reportedly collected from a portion of what was assumed to be the former wooden flume; one sample contained 0.57 mg/kg PCBs (Aroclor 1254). This wood sample also contained detectable concentrations of xylenes, naphthalene, 2-methylnaphthalene, BEHP, cadmium, chromium, copper, lead, mercury, nickel, and zinc (Bridgewater Group 2000). The contamination was attributed to aircraft fuel testing activities over a period of 40 years; according to Boeing, company records indicated no evidence of PCB-related activity at this location (Boeing 1995b).

In March 1996, an estimated 200 cubic yards of soil were removed to a depth of approximately 5 feet (about 6 inches beyond the depth to groundwater). A total of 18 soil samples were collected, including 12 samples from the sides of the excavation, one test pit sample, and five soil stockpile samples. In addition, the groundwater monitoring well previously installed at the site was abandoned (SEACOR 1996b). Soils within the remediation area (collected from the sides of the excavation) contained gasoline, diesel, and oil range hydrocarbons at concentrations up to 4,700, 9,900, and 14,000 mg/kg, respectively (SEACOR 1996b). Of the 12 excavation samples, three exceeded the gasoline range cleanup level, four exceeded the diesel range cleanup level, and two exceeded the total recoverable range cleanup levels. No exceedances were reported for the test pit. None of these samples were analyzed for PCBs.

The five stockpile soil samples were analyzed for PCBs, metals, and VOCs in addition to TPH. PCBs were detected in all five stockpile soil samples, at concentrations ranging from 0.91 to 1.6 mg/kg [83,90]. VOCs (including acetone, chloroform, and 2-butanone) were detected in four of the stockpile soil samples at concentrations up to 0.014, 0.0054, and 0.078 mg/kg, respectively. Barium (23.2 to 25.3 mg/kg), chromium (9.6 to 14.9 mg/kg), lead (5 to 7 mg/kg), mercury (0.05 mg/kg) and silver (0.3 to 0.4 mg/kg), were detected in one or more of the stockpile soil samples. Arsenic, cadmium, and selenium were below detection limits. All five samples contained gasoline and diesel range hydrocarbons; two samples contained oil range hydrocarbons.

TPH impacts appeared to be localized near the groundwater surface. A sheen was observed on groundwater that accumulated in the excavation. TPH-impacted soil at concentrations above MTCA Method A soil cleanup standards remained in place along the north, south, and east sides of the excavation at the groundwater interface (SEACOR 1996b).

Additional investigations were reportedly conducted by Equipoise (1997) on behalf of Boeing; these and other investigations in the Building 3-333 area showed areas of TPH and PCB contamination, with the highest concentrations located near MW-1 (TPH to 12,000 mg/kg; PCBs to 510 mg/kg) (AGI 1998a). A 1996 cleanup action included the removal of 14 55-gallon drums of PCB-containing soil and additional soil sampling. PCBs and several VOCs (1,1,1-trichloroethane, trichloroethene, trichlorotrifluoroethene, and trichlorofluoromethane) were detected during excavation activities. PCBs (Aroclor 1254) were found in soil at the bottom of the excavation up to 84 mg/kg (Bridgewater Group 2000). Soil samples were not obtained from the final excavation limits.

Prior to Phase II construction (the west wing of Building 3-333) in 1998 (Boeing 1998a), a supplemental investigation was conducted to more clearly define the vertical and lateral extent of contamination within the boundaries of the Phase II construction, at the former location of Buildings 3-321, 3-287, and 3-320 (AGI 1998a). The investigation included collection of subsurface soil samples and analysis for TPH, PCBs, and methylene chloride (included because this compound had historically been used and stored onsite at this location). In general, the highest TPH and PCB concentrations were localized in the area between Buildings 3-321 and 3-287. Maximum TPH concentrations were 7,800 mg/kg and 7,600 mg/kg for gasoline range and diesel range, respectively. These were detected in samples collected from just above the water table around monitoring well MW-1. The maximum PCB concentration (1,600 mg/kg) was detected in a boring located approximately 10 feet from MW-1 (AGI 1998a). Methylene chloride concentrations did not exceed MTCA Method A cleanup levels.

Remedial action was conducted to excavate subsurface soils with concentrations exceeding MTCA Method A industrial soil cleanup levels to the depth of the water table. Excavation was conducted during August and September 1997, including the removal of a visibly stained concrete drain trough in the floor slab along the north edge of the former Building 3-320 and concrete pavement between former Buildings 3-321 and 3-287, and the southwest corner of the Building 3-287 floor slab. The southwest side of the current Building 3-333 is now at this location. Onsite laboratory analysis included 62 samples analyzed for PCBs and 40 samples analyzed for TPH (AGI 1998a). In addition, 23 confirmation samples were analyzed for PCBs and 25 samples were analyzed for TPH.

Numerous active and abandoned utilities were encountered during excavation, including electrical conduits, sanitary sewer lines, storm sewer lines, water mains, compressed air lines, and "pipes of unknown origin" (AGI 1998a). Near the north sidewall of the excavation, an 8-inch diameter ductile iron pipe with the end broken off was discovered. Approximately 1 inch of a black oily substance was located inside the pipe; tests indicated that this substance contained PCBs (to 25,300 mg/kg) and TPH (to 25,500 mg/kg). The broken end of the pipe was located about 3 feet from MW-1, and may be a source of the elevated PCBs found near MW-1 (AGI 1998a). The open west end of the pipe terminated near a north-south trending concrete storm drain pipe; excavations on the west side of the storm drain did not locate a continuance of the ductile pipe. According to drawings supplied by Boeing, the ductile iron pipe may have been connected to floor drains in Buildings 3-320 and 3-287 and to a nearby catch basin (AGI 1998a). Similar ductile iron pipe was found near the northwest corner of Building 3-320; two pipes were found that terminated where they encountered utility pipes connected to the existing storm drain at the northwest corner of Building 3-320. Analysis of samples collected from the interiors of these pipes and invert subgrades did not show PCB levels above MTCA Method A cleanup levels (AGI 1998a).

Aroclor 1254 was the only PCB detected during onsite laboratory samples. Excavation soil samples found PCBs above the MTCA Method A soil cleanup level (10 mg/kg) at 3.4 to 5.2 feet bgs with a maximum concentration of 4,150 mg/kg (near the ductile iron pipe described above) and diesel range TPH to 7,730 mg/kg.

Confirmation samples were collected from upper and lower sampling intervals along each sidewall. Results indicate that elevated PCB concentrations (above MTCA Method A cleanup levels) remain on the east wall of the excavation (to 51 mg/kg) and on the bottom of the MW-1 excavation (below the water table; to 380 mg/kg). Residual PCB concentrations in other locations ranged from nondetect to 6.3 mg/kg Aroclor 1254 (bottom of excavation) and to 3.2 mg/kg Aroclor 1260 (drainage trough drain under Building 3-320) (AGI 1998a). Elevated TPH concentrations (TPHd to 4,300 mg/kg, TPHg to 1,200 mg/kg, and motor oil range TPH to 260 mg/kg) were found in these same locations. No further action was taken.

4.3.1.8 Oil/Water Separator UBF-55 and Tank UBF-27 (1997)

According to Boeing, this location bordered an old Seattle City Light transformer storage area (AGI 1998b). To the north of the site is the fenceline between NBF and GTSP, near the "low-lying area" as described in Section 3.4.6 above. The site is bounded by a gas meter to the northwest, the air-gas dryer area to the southwest, and Buildings 3-322 and 3-326 to the southwest and southeast, respectively.

SCL conducted a PCB cleanup in Fall 1985 in this area, which included soils on SCL's side of the fenced boundary (the low-lying area, see 3.4.6) (Boeing 1986f).

A 3,000-gallon underground fuel oil storage tank (UBF-27) was located near the northwest corner of Building 3-326. The tank was removed in May 1986; a sample of fluid from the tank was analyzed prior to excavation and did not contain PCBs (Boeing 1986f). Boeing collected soil samples during the tank excavation and analyzed them for PCBs (Boeing 1986d). A composite sample from the upper 4 feet of soil indicated 40 mg/kg Aroclor 1248. A sample collected from beneath the tank at a depth of 8 feet contained 13 mg/kg Aroclor 1248 (Boeing 1986f). Approximately 30 cubic yards of PCB-contaminated soil were removed from an excavation measuring 13 feet long by 8 feet wide by 12 feet deep (Boeing 1986g). Composite samples were collected after excavation at a depth of 12 feet at two locations: 3 feet from SCL property (43 mg/kg Aroclor 1254), and 18 feet from SCL property (15 mg/kg Aroclor 1242/1254). The excavation was backfilled with crushed rock and covered with asphalt; no further remedial actions were planned (Boeing 1986f).

In September 1997, AGI Technologies conducted a site investigation for the OWS designated as UBF-55 (Figure A) (AGI 1998b). This OWS, currently identified as OWS-186, was located in the northwest portion of North Boeing Field, near the northeast corner of Building 3-322, adjacent to UBF-27, and near the GTSP low-lying area described previously. The 5,000-gallon capacity steel OWS was installed in 1976 (AGI 1998b).

The purpose of the investigation was to determine the horizontal and vertical extent of potential contamination. Subsurface soil samples were collected at 18 locations, based on a grid centered around the OWS. Samples were analyzed for TPH, PCBs, VOCs, and/or semi-volatile organic compounds (SVOCs). Samples were typically collected from an upper interval (1 to 1.5 feet thick) just below the asphalt, and a second interval (usually 2 feet thick) directly above the water table (AGI 1998b). After samples were collected, the sampling locations were backfilled with bentonite chips and sealed at the surface with concrete patch.

Fill was encountered immediately below the asphalt; this material was highly variable in type and thickness (up to 4 feet), and included poorly graded sand (0.5 to 3.5 feet thick); pea gravel (near the former location of UBF-27; to a depth of 4.2 feet); sandy silt (0.5 to 1 foot); well-graded sandy gravel; clean, poorly graded gravel; and graded sand. Below the fill material, native alluvial sediments consisting of poorly graded sand were encountered to the base of the sample probes. At some locations, interbedded layers of silt were present. Groundwater was encountered at depths of 4.1 to 4.3 feet below grade.

Field screening of soil samples was conducted. Staining was observed in the lower sample interval (4.1 to 7.1 feet bgs) from probe P16. Organic vapor screening indicated the presence of VOCs in both the fill and native soils. The highest readings in the fill were located at P6 and P3 (9.9 and 57.5 ppm, respectively). The highest organic vapor reading in the alluvium was 174.6 ppm at P16.

Only four of the 18 upper interval samples were analyzed for PCBs. These were the locations closest to the OWS (P6, P7, P16, and P17).

Sample results are shown in Table 2. Detected Aroclors were primarily 1248 and 1254. Total PCBs ranged from 0.09 to 1,540 mg/kg PCBs (AGI 1998b). The highest concentrations (172 mg/kg to 1,540 mg/kg) were found at sample locations P16 and P7, located immediately to the south and north of UBF-55, in both upper and lower sample intervals. PCB concentrations above 10 mg/kg were also detected in P2, P3, P4, and P9, which are the sample locations closest to the gas meter and GTSP. No operational source for this PCB contamination has been identified.

Maximum detected gasoline, diesel, and motor oil concentrations were 150, 1,900, and 550 mg/kg, respectively. The highest concentrations were detected in P3 and P16. One sample (P3) contained gasoline-range petroleum hydrocarbons at a concentration above the current MTCA Method A cleanup level of 100 mg/kg.

Four samples were analyzed for VOCs and SVOCs. Two VOCs were detected: acetone (two samples; 0.016 to 0.030 mg/kg); and toluene (one sample; 0.002 mg/kg). Four SVOCs were also detected: phenanthrene (one sample, 0.11 mg/kg); pyrene (one sample, 0.2 mg/kg); BEHP (three samples, 0.11 to 0.24 mg/kg); and chrysene (two samples, 0.11 mg/kg) (AGI 1998b).

No cleanup actions were identified.

4.3.1.9 Building 3-304 (2000–2001)

Building 3-304 was located in the northwest portion of NBF. Prior to demolition and installation of a new utility corridor, a site investigation was conducted to evaluate soil conditions. The site investigation, which was completed in October 2000, evaluated the vertical and lateral extent of potential contaminants in soil to be excavated, and specifically included areas to be excavated for the new utility trench and footings (CDM 2000). After coring through existing concrete, soil borings at nine locations were hand augered and sampled for VOCs, PCBs, TPH, and total metals. Fill was encountered at some locations immediately below the concrete flooring and was generally 3 to 6 inches thick. Analytical results indicated low concentrations of 2-hexanone, toluene, and xylenes, all below MTCA Method A cleanup levels. PCBs were detected in one sample (SS-3304-1[1']) at 1.5 mg/kg total PCBs (0.85 mg/kg Aroclor 1254, 0.65 mg/kg Aroclor 1260) (CDM 2000). Petroleum hydrocarbons were detected in seven of nine borings at concentrations ranging from 11 to 300 mg/kg diesel range hydrocarbons and 16 to 730 mg/kg motor oil range hydrocarbons. Barium (to 65.4 mg/kg), cadmium (to 1.6 mg/kg), chromium (to 34.6 mg/kg), lead (to 81 mg/kg), mercury (to 5.1 mg/kg), and silver (to 0.5 mg/kg) were also detected in the soil samples (CDM 2000). TPH and mercury were present above MTCA cleanup levels in one sample location each, in the southwest area of Building 3-304; all other analytes were below MTCA cleanup levels.

During excavation of the new utility trench within the north end of Building 3-304, an apparently abandoned concrete structure was discovered approximately 4 feet below the floor slab (CDM 2001). The structure measured approximately 3 feet high by 6 feet in length, was filled with concrete debris, and a concrete pipe attached to the south end had been plugged with poured concrete. The actual function of the structure was unknown, but it may have been an OWS serving the building, which was abandoned in place. Upon removal of the structure, a sheen was noted on the groundwater in the excavation, and the soils had a fuel-hydrocarbon-like odor (CDM 2001). A soil assessment was conducted in November 2001 to document the concentration of fuel compounds and other chemicals in soil at the edges and base of the excavation. Five samples were collected from the sidewalls and base of the excavation on November 5, 2001. Petroleum hydrocarbons were detected in samples S4 and S5 (north sidewall and base of excavation, respectively). Gasoline range hydrocarbons ranged from 67 to 1,100 mg/kg, diesel range hydrocarbons ranged from 160 to 300 mg/kg, and motor oil range hydrocarbons ranged from 81 to 130 mg/kg (CDM 2001). Ethylbenzene, xylenes, 1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene, isopropylbenzene, n-propylbenzene, sec-butylbenzene, 4-isopropyltoluene, and n-butylbenzene were detected at low levels in sample S5. Carcinogenic PAHs were not detected. PCBs were detected in sample S4 at 1.8 mg/kg (Aroclor 1254). Arsenic (to 11 mg/kg), chromium (to 12.4 mg/kg), lead (to 19 mg/kg), and mercury (2.68 mg/kg) were also detected (CDM 2001). Mercury exceeded the MTCA Method A cleanup level, but was below the Method C (industrial) cleanup level.

4.3.2 Soil and Groundwater Investigations – Central Portion of Site

4.3.2.1 Flight Test and Delivery Center, Building 3-800 (1989–1993)

Building 3-800, the Flight Test and Delivery Center, is located immediately north of Building 3-818 and northeast of Building 3-801. An investigation conducted prior to construction of Building 3-800 included excavation of 40 test pits and five monitoring wells. TPH was detected above the MTCA Method A cleanup level in soil samples from four test pits located in the southwestern portion of the proposed building, adjacent to a heating oil UST (Hart Crowser 1990a, as cited in (SEACOR 1991a)).

In late 1989/early 1990, the heating oil UST was removed and approximately 1,980 cubic yards of soil containing TPH above MTCA Method A cleanup levels were excavated from three separate areas: 1,280 cubic yards from the "tank excavation," 300 cubic yards from the "boring B-5 area," and 400 cubic yards from a "sewer line excavation" (Hart Crowser 1990b, as cited in SEACOR 1991a). Verification samples indicated that the "majority" of soil above MTCA Method A cleanup levels had been removed (SEACOR 1991a).

In February 1990, Boeing notified Ecology that they had discovered an underground concrete structure during construction of Building 3-800 (Boeing 1990a). Boeing records indicated that this structure was a septic tank, which was removed from service sometime in 1955. Sludge and water inside the structure were found to contain low-level volatile and semivolatile organic compounds (Boeing 1990a). The concrete tank, approximately 12 feet long by 8 feet wide by 6 feet deep, located approximately 160 feet northeast of the proposed Building 3-800 location, was removed in early 1990.

Six borings, four shallow wells (11.5 to 13 feet bgs), and five deep groundwater monitoring wells (29 to 35 feet bgs) were installed and sampled. Results indicated low levels of VOCs in soil, although one sample contained tetrachloroethene (PCE) above the MTCA Method A cleanup level. Further excavation was not conducted due to concerns of undermining and possibly damaging adjacent structures (SEACOR 1992f). In groundwater, vinyl chloride, TCE, and/or PCE were present above MTCA Method A groundwater cleanup levels in three wells (Hart Crowser 1991, as cited in (SEACOR 1991a)). Water level data indicated that groundwater was moving toward the west at a gradient of 0.001 to 0.002 feet per foot. Little or no vertical gradient was observed.

In 1992, a site assessment investigation was performed at the location of the former concrete underground tank, adjacent to Building 3-800, to further assess the presence of VOCs, SVOCs, and metals in this area (SEACOR 1992f). The investigation area was relatively flat, with a slight slope to the south toward several storm drains that lie adjacent to Building 3-800. The area is paved with asphalt.

Soil sampling results indicated that VOCs, SVOCs, and most metals were either not detected or were detected at concentrations below MTCA cleanup levels. Beryllium was detected at 0.23 mg/kg, slightly above the MTCA Method B cleanup level. VOCs were detected in all soil borings, although the most frequent detections (carbon disulfide, cis-1,2-DCE, chloroform, vinyl chloride, 2-butanone, TCE, and toluene) were associated with two soil borings (MW-103B and MW-104A) located northwest of the former concrete underground tank. SVOC detections (benzoic acid, diethyl phthalate, fluoranthene, pyrene, benzo(a)anthracene, BEHP, chrysene) were limited to two soil borings (MW-101B and MW-103B), located north and west of the former concrete underground tank (SEACOR 1992f).

In groundwater, vinyl chloride, TCE, PCE, cis-1,2-dichloroethene, BEHP, arsenic, chromium, lead, and beryllium exceeded their respective MTCA cleanup levels. Impacted wells are located hydraulically lateral to or downgradient from the former underground concrete tank (SEACOR 1992f). Most VOC detections were associated with shallow groundwater wells, although vinyl chloride was detected above MTCA Method A cleanup levels in both shallow and deep wells. Those VOCs with densities greater than water (i.e., TCE, PCE) do not appear to have migrated to deeper water bearing zones at these locations (SEACOR 1992f). Detected SVOCs (acenaphthene, fluoranthene, benzo(a)anthracene) were generally below MTCA cleanup levels, except for BEHP, which was detected at 18 ug/L in a single sample (Well MW-102B). Metals were detected in both shallow and deep wells at concentrations exceeding MTCA Method A or B cleanup levels.

None of the samples were analyzed for PCBs.

An independent soil remedial action was conducted for an underground storage tank at this location in 1993. A report was submitted to Ecology on May 10, 1993 (Boeing 1998c); however, this report was not found in the files. Apparently, this report indicated that remedial actions were complete. Buildings now occupy this location.

4.3.2.2 Flight Test Engineering Lab, Building 3-801 (1991–1992)

A pre-construction environmental investigation was conducted at the location of proposed Building 3-801 (Flight Test Engineering Laboratory) (SEACOR 1991a) in 1991. The site is approximately 100 feet by 200 feet in size, and is located immediately west of the Flight Test and Delivery Center (Building 3-800). A satellite dish and electrical substation lie within and immediately adjacent to the northwest corner of the proposed building pad. The site slopes slightly toward the east toward several storm drains that lie between the existing Building 3-800 and the proposed Building 3-801. A storm sewer line is located within the site, and a UST is located just off the northwest corner immediately east of the substation. The tank presumably contained fuel for a generator that supplied auxiliary power for the substation (SEACOR 1991a).

During the investigation, 21 soil borings were drilled and four monitoring wells were installed (SEACOR 1991a). Groundwater was encountered between 7 and 8 feet bgs. Twenty four soil samples and 5 groundwater samples were collected and analyzed for TPH; a subset of samples was analyzed for VOCs, and/or priority pollutant metals. Elevated concentrations of metals were observed: copper (153 mg/kg), zinc (175 mg/kg), and cadmium (2.1 mg/kg) were slightly above the MTCA Method A cleanup levels. Petroleum hydrocarbons were detected in soil borings at concentrations up to 17,000 mg/kg. Low levels of TCE (to 0.4 mg/kg), PCE, and xylenes were detected in one boring. In addition, monitoring well #4 contained arsenic above the MTCA Method A groundwater cleanup level of 5 ug/L.

King County requested that the source of arsenic in groundwater be investigated, and that monitoring well #3 be sampled for priority pollutant metals, and indicated that remediation of TPH contamination would be required (King County 1991a).

In September 1991, a supplemental pre-construction environmental investigation of the proposed Building 3-801 site was conducted. The purpose of the investigation was to assess the potential presence of priority pollutant metals in groundwater from Well MW-3 and to verify the previously detected concentrations of priority pollutant metals in Well MW-4 (SEACOR 1991b). Analytical results of groundwater samples indicated the presence of antimony (21 ug/L) and arsenic (6.4 ug/L) in MW-3 above MTCA groundwater cleanup levels; antimony (57 ug/L), arsenic (6.5 ug/L), chromium (92 ug/L), and lead (8.1 ug/L) were detected in MW-4 at concentrations above MTCA groundwater cleanup levels (SEACOR 1991b).

In addition, four soil borings were drilled and sampled radially from Well MW-4; samples collected from a depth of 3 and 8 feet in each boring indicated the presence of arsenic in all four borings at concentrations ranging from 0.94 to 7.5 mg/kg. The report indicates that these concentrations are below MTCA Method A cleanup levels, but neglects to point out that they exceed the MTCA Method B cleanup level. The study concludes that soil in the vicinity of MW-4 is unlikely to be the source of arsenic in groundwater at this location (SEACOR 1991b). A potential source of arsenic could not be identified.

A subsequent letter from King County to Boeing indicated that the supplemental pre-construction environmental investigation report did not fully respond to their earlier letter (King County 1991b).

During March 1992, Boeing conducted an independent soil remedial action at the proposed Building 3-801 location (SEACOR 1992e). Petroleum-impacted soil was removed within and near the southeast portion of the proposed building location; additional excavation for a utility trench was performed in May 1992 at the northern end of the building footprint. Fifty-three excavation soil samples were collected in areas where potentially impacted soil was observed, and at select locations to confirm that potentially impacted soil was not present or had been removed. In addition, 16 stockpile soil samples, one test pit soil sample, and five excavation water samples were collected. All samples were analyzed for TPH only. Petroleum-impacted soils remain at concentrations above the MTCA Method A cleanup level for TPH (200 mg/kg) along a portion of the eastern perimeter of the excavation at depths between 5 ½ feet and 8 feet bgs (SEACOR 1992e). These soils were not excavated due to the potential for compromising the integrity of existing structures. No samples were analyzed for PCBs.

4.3.2.3 Buildings 7-027-1, 7-027-2, and 7-027-3 (1991)

A pre-construction environmental investigation was conducted at this location in November 1991 (SEACOR 1992a). The site consists of approximately 1.2 acres of property encompassing Buildings 7-027-1, 7-027-2, 7-027-3, and 3-300, located on the northwest side of NBF. It is bounded by a parking lot to the north, E. Marginal Way to the south, Occidental Avenue to the east, and a concrete ditch and hotel to the west. The asphalt area south of Building 7-027-1 is the location of a former service station (SEACOR 1992a). The site is at an elevation of approximately 12 feet above MSL; topography is relatively level with a slight slope toward the west. Groundwater was encountered at depths from 7.5 to 11 feet bgs.

During the investigation, 16 soil and 4 groundwater samples were collected and submitted for chemical analysis. Soil borings were drilled to depths ranging from 7 to 21.5 feet. TPH, benzene, and metals were detected in soil samples; none of the analytes exceeded their respective MTCA Method A soil cleanup levels. TPH, benzene, ethylbenzene, methylene chloride, toluene, trichloroethene, xylenes, copper, lead, and zinc were detected in groundwater. TPH (1.7 to 2.0 mg/L), ethylbenzene (100 ug/L), trichloroethene (24 ug/L), and total xylenes (380 ug/L) exceed MTCA Method A groundwater cleanup levels (SEACOR 1992). PCBs were not detected; however, only two soil samples and one groundwater sample were analyzed for PCBs. In addition, the detection limit for PCBs in groundwater was 10 times higher than the MTCA Method A cleanup level.

A supplemental site investigation was conducted in February 1993 to assess subsurface soil and groundwater conditions at the site relative to select chemicals and to supplement previously collected data (SEACOR 1993). Ten subsurface soil samples and four groundwater samples were collected and analyzed for TPH-G and TPH-D; in addition, a subset of soil and groundwater samples were analyzed for BTEX and/or VOCs. Contaminants in groundwater were below MTCA Method A cleanup levels with the following exceptions: TPH-G, ethylbenzene, and xylenes in MW-2; vinyl chloride and TCE in MW-3; vinyl chloride in MW-4. Vinyl chloride and TCE were detected at concentrations to 1.2 ug/L and 22 ug/L, respectively (SEACOR 1993). Data indicate that groundwater was moving to the south at a gradient of 0.0016 feet per foot. Contaminants in soil were below MTCA Method A cleanup levels.

4.3.2.4 Main Fuel Farm (1991–1994)

Soil and groundwater investigations were conducted at the Main Fuel Farm, located in the central portion of NBF adjacent to and south of Building 3-818, during 1991 and 1992. The Main Fuel Farm site includes Building 3-822, two 30,000-gallon ASTs near the northwest site boundary, a concrete OWS and a 6,000-gallon AST near the northeast site boundary, a fuel island near the western portion of the site, and a raised concrete pad near the center of the site (SEACOR 1992c). The concrete pad overlies three USTs (UBF-1, UBF-2, and UBF-3), which are used for the storage of jet fuel. The eastern margin of the fuel farm is bounded by a 20-foot high concrete blast wall (SEACOR 1994d).

In December 1991, the three USTs failed a leak test. According to the ERT System report, product was seeping out of the concrete (Ecology 1991b). Nine 15-foot soil borings were drilled and monitoring wells installed in March 1992. Thirty-five soil samples from the nine soil borings and 15 groundwater samples from existing and newly installed wells were collected and analyzed for TPH and BTEX (SEACOR 1992c). Depth to groundwater ranged from 6.95 to 8.74 feet. Dissolved hydrocarbons were detected in groundwater at concentrations to 58 mg/L TPH and 20 ug/L benzene. Concentrations exceeded MTCA Method A cleanup levels in wells MF-12, MF-18, MF-19, MW-20, and MW-28, located immediately north of the jet fuel USTs. Floating NAPL was found in two wells (MF-13 and MF-14) located south and east of the jet fuel USTs. In soil, TPH was detected in five of the soil borings; one sample (MW-20, 430 mg/kg at 8.5 feet bgs) exceeded the MTCA Method A cleanup level for TPH (SEACOR 1992c). BTEX was not detected in the soil samples. None of the samples were analyzed for PCBs.

Quarterly groundwater monitoring data during 1992 indicated the presence of light non-aqueous phase liquid (LNAPL) in three wells: MF-13, MF-14, and MW-20. These wells were located south of the OWS and east of the USTs. Between July 21, 1992, and October 5, 1992, an LNAPL extraction system was installed and operated by Boeing (SEACOR 1994d). During this time, approximately 450 gallons of LNAPL were recovered. Recovered groundwater was treated by granular activated carbon (GAC) and discharged to the sanitary sewer under Metro Discharge Authorization No. 362 (SEACOR 1992d).

In December 1992, UBF-1, UBF-2, and UBF-3 were decommissioned by excavation and removal. LNAPL was observed overlying the groundwater during the decommissioning activities (SEACOR 1994d). Soil samples analyzed during soil boring and well installation activities and UST decommissioning indicated that TPH above MTCA Method A cleanup levels were present at locations southwest of the OWS, and along the northeastern side of the UST excavation, adjacent to the former location of tank UBF-1 (SEACOR 1994d).

In June 1994, the concrete OWS, located in the northeast portion of the investigation area, was removed as part of a subsurface site assessment and independent soil cleanup action conducted by Boeing (SEACOR 1994d). Due to structural concerns associated with the blast wall, the east wall of the OWS was left in place. An estimated 3,500 cubic yards of soil were removed from the area south and west of the OWS; an additional 200 yards of soil were removed from the area north of the OWS, which formerly contained an LNAPL recovery trench (which was operated in July and October 1992).

Thirty four confirmation soil samples were collected from the excavation sidewalls, as well as 19 stockpile characterization samples, including concrete and soil stockpile samples. Samples were analyzed for TPHg, TPHd, and total recoverable TPH, and some samples were also analyzed for BTEX, PCBs, SVOCs, and TCLP metals.

Results indicated that residual petroleum-hydrocarbon impacted soil is present at limited areas in shallow soil (less than 5.5 feet bgs) on the east side of the excavation, beneath the blast wall (SEACOR 1994d). In addition, residual impacted soils may remain beyond the lateral extent of the excavation in deeper soil (greater than 5.5 feet bgs) on the north, south, and east sidewalls. Impacted areas were generally within 1 foot above the observed depth to groundwater (i.e., within the capillary fringe). In addition to TPH, a variety of organics were detected. In the excavation soil samples, low levels of VOCs were detected. PAHs were detected in all five samples for which SVOCs were analyzed. Two samples (WW-19 and SW-21), located near the former UST area, contained PAHs above MTCA Method B cleanup levels: chrysene (0.28 and 7.3 mg/kg), benzo(b)fluoranthene (0.20 and 6.0 mg/kg), benzo(k)fluoranthene (0.26 and 2.8 mg/kg), and benzo(a)pyrene (0.19 and 4.3 mg/kg) (SEACOR 1994d). PCBs were analyzed in five samples; Aroclors 1016/1242, 1248, and 1254 were reported in sample SW-21 at 0.15 to 0.31 mg/kg. A "Y" data qualifier (raised detection limit due to interference) was applied to these results; while the text of the site assessment report identifies these as detections, they should have been identified as non-detects (SEACOR 1994d). No other PCB detections were reported in the confirmation samples.

A wide variety of volatile and semivolatile organics were detected in the stockpile samples, including BTEX, PAHs, and phthalates.

4.3.2.5 Concourse C Flight Line Utility Corridor (1991–1992)

The Flight Line Utility Corridor near Concourse C was approximately 10 feet wide and contained a variety of subsurface utilities including a fire main, water line, foam water line, foam line, air line, refuel/defuel lines, and a 30-inch storm drain line (SEACOR 1992b). Two power stations, a water vault, and an air/water vault are also located along the corridor. The Main Fuel Farm is located to the west of the Utility Corridor. A Phase I soil assessment investigation was conducted at this location in 1991. Eight soil borings were drilled to a depth of approximately 8.5 feet; 31 samples were collected from these borings and analyzed for TPHd and VOCs. In addition, 21 hand auger borings were completed and 31 samples were collected and analyzed for TPHd. In addition, one sample of stockpiled soil generated during the removal of the concrete apron at Concourse C was analyzed for TPHd, VOCs, and PCBs.

TPHd, methylene chloride, acetone, total xylenes, benzene, toluene, ethylbenzene, 2-butanone, and 1,1,1-trichloroethane (TCA) were detected in borehole samples (SEACOR 1992b). TPHd was detected at <10 to 2,500 mg/kg; TPHd in boring B-2 exceeded the MTCA Method A cleanup level of 200 mg/kg. The other compounds were present at concentrations below the Method A cleanup level. The hand auger borings indicated the presence of TPHd above Method A cleanup levels in four borings, at concentrations ranging from 220 to 4,400 mg/kg. In the stockpile soil sample, TPHd was detected at 1,600 mg/kg and acetone was detected at 1.2 mg/kg. No PCBs were detected at a detection limit of 0.10 mg/kg (SEACOR 1992b).

Based on results of the Phase I investigation and field observations in conjunction with the removal of existing subsurface utilities and installation of a utilidor, impacted soil was excavated along the Concourse C Flight Line during November 1991 through January 1992 [149, 96]. The excavation area covered approximately 330 linear feet immediately west of airplane positions C3 and C4 at Concourse C, and followed the course of the existing subsurface utilities. Installation of the utilidor required an area of about 15 feet wide by 10 feet deep along the 330 linear foot area. Overexcavation was conducted in areas where impacted soil was anticipated based on the Phase I sampling results and where field evidence of petroleum-affected soil was observed. A total of 18 confirmation samples were collected and analyzed for TPHd; one sample was also analyzed for BTEX (not detected). TPHd was present in 6 of the 18 confirmation samples, at concentrations below the MTCA Method A soil cleanup level (SEACOR 1992b).

However, hydrocarbon-like odors and elevated photoionization detector (PID) readings were observed in the northeast corner of the excavation area and may represent residual hydrocarbon-impacted soil. In addition, TPHd at 220 mg/kg was observed in hand auger boring HA-13 (at a depth of 3 feet bgs), a location that was not included in the utilidor excavation. The Independent Cleanup Action Report concludes that due to the lateral distance between HA-13 and the utilidor excavation, it is unlikely that the detected TPH in this boring is related to hydrocarbons observed within the excavation area, and may represent a localized occurrence of low levels of TPH (SEACOR 1992b).

Boeing subsequently filed a notice to close the USTs adjacent to this area (Boeing 1992g).

4.3.2.6 UBF-22 and UBF-23, Building 3-374 (1995)

During decomissioning and removal of two 20,000-gallon #6 fuel oil underground storage tanks (UBF-22 and UBF-23), located near Building 3-374 and used for storage of backup fuel, odor and soil staining were observed, which indicated the potential presence of petroleum hydrocarbon contamination. An investigation and corrective action was conducted, which included the removal of approximately 135 cubic yards of soil (Boeing 1995a). Excavated soil showed up to 440 mg/kg TPH, all within the diesel range. Soil contamination did not extend to the water table, and a site assessment confirmed removal of all TPH-impacted soil (SEACOR 1994e). None of the soil samples were analyzed for PCBs.

4.3.3 Storm Drain Sampling and Cleanout

Extensive sampling of solids from storm drain structures including catch basins, manhole access locations, and OWSs throughout the Boeing-leased property has been conducted between 1984 and 2006.

4.3.3.1 Chronology

A chronology of sampling and cleanout activities is provided below.

1980s

- A map showing samples collected at NBF in August 1984 provided results of sampling for PCBs along the storm drain line near the northern boundary with the GTSP. Six samples were collected; all but one contained total PCBs in the range of 360 to 600 mg/kg (Boeing 1984a). Detected PCBs were primarily Aroclors 1242 and 1254 (Boeing 1984b).
- In 1984, Boeing proposed to clean the PCB-contaminated storm drain, which is tributary to the Georgetown Flume. Permission was requested by Boeing to discharge pre-treatment cleanup water to the sanitary sewer (METRO 1984b).
- On August 9, 1985, FAMCO Transport employees were observed dumping 55-gallon drums of oily material through a Boeing property fence and into a storm drain on Boeing property (west side of GTSP). Subsequent testing of the drain system by FAMCO's contractor reportedly indicated the presence of PCBs, heavily enveloped in solvent, in manhole SD-A18-MH (Boeing 1986b). An investigation to identify the source of PCBs was subsequently conducted by Boeing. On October 4, 1985, sediments from manholes SD-A18-MH, SD-A2-MH (downstream of SD-A18-MH), and the storm drain near FAMCO (between SD-A26-MH and SD-A20-MH) were analyzed. SD-A18-MH is located on the eastern edge of the Georgetown flume near Building 3-323. PCBs were not detected in the storm drain near FAMCO, but were found at concentrations of 905 and 18.8 mg/kg in SD-A18-MH and SD-A2-MH, respectively (Boeing 1986b).

  Further sampling was conducted upstream from Boeing property (on Air National Guard and King County property) to determine whether PCBs were migrating from another source. Low concentrations of PCBs (0.03 to 0.07 mg/kg) were detected. In addition, acetone, toluene, and xylenes were detected in the Air National Guard site sample at concentrations of 0.16 mg/kg, 0.11 mg/kg, and 0.049 mg/kg, respectively (Boeing 1986b).

  Further sampling to identify the source of the PCBs was subsequently conducted. An upstream manhole sediment sample contained 0.86 mg/kg PCBs. Manhole SD-A18-MH (located closest to FAMCO) contained 99 mg/kg PCBs, while the downstream sample from manhole SD-A2-MH contained 160 mg/kg PCBs (Boeing 1986b). PCBs were mainly Aroclor 1254. From these results, Boeing concluded that PCB-laden solvent had been dumped into SD-A18-MH; although Boeing maintained that they had not caused this release, they agreed to clean the storm drain to prevent further spread of PCBs into the environment (Boeing 1986b). The following cleanup actions were planned: (1) hydroblasting of storm drain piping beginning at manhole SD-A20-MH to manhole SD-A1-MH; and (2) cleaning of two OWSs, which had collected sediment due to tidal influence back flushing (Boeing 1986b).

  Follow-up sampling was conducted on December 2, 1986, from manhole SD-A18-MH and a location downstream of manhole SD-A-5 (located southwest of Building 3-315). PCB concentrations were 8.9 mg/kg and 4.9 mg/kg, respectively (Boeing 1986h).

1990s

- In 1992, during scheduled maintenance cleaning of the storm sewer system, Boeing discovered PCBs and TPH in concentrations exceeding MTCA Method A cleanup levels in soils/sediments that had accumulated in the rainwater storm sewer piping system (Boeing 1993e). An investigation was subsequently conducted (Landau 1993a).
- In July 1992, soil was collected from 25 storm drain manholes and catch basins at main branch point locations in those portions of the system that drain to Slip 4. Two soil samples were also collected from the Georgetown Flume, one sample from an OWS, and one sample from the lift station. The sampling locations were concentrated at the north end of NBF. In August 1992, two locations were re-sampled and samples were collected at five additional locations (Landau 1993a). Invert elevations (the lowest point at the sampling location in which water can flow) were measured at most sampling locations as well as manholes and catch basins to determine elevation trends in the storm sewer lines.

  Soil samples were analyzed for PCBs, TPH, and total organic carbon (TOC). Concentrations of up to 526 mg/kg PCBs and 14,000 mg/kg TPH were detected in sediments at the north end of the facility, near the GTSP; concentrations up to 1,240 mg/kg[5] PCBs and 3,000 mg/kg TPH were observed in the flight line area (Boeing 1992h). Aroclors 1254 and 1260 were the predominant contaminants. TOC values ranged from 0.6 percent to 13.3 percent.
- In a letter to Ecology dated September 23, 1992, Boeing pointed out that the adjacent SCL property is elevationally higher than NBF and is known to have extensive PCB contamination of soils, and therefore the presence of contaminated sediment in storm drains at the northern end of NBF is most likely due to stormwater run-on from the SCL property (Boeing 1992h). In addition, the letter indicates that although there are no apparent sources of PCBs in the flight line area, these storm drains were, until 1990, directly connected to Slip 4 and subject to tidal back flushing from the slip (Boeing 1992h).
- Between October and December 1992, accessible soils/sediment were removed from the storm drain system by pumping water under high pressure into isolated segments of the system. The resulting solid/liquid mixture was dewatered, and both the dewatered soil and decanted water were sampled for chemical characterization (Landau 1993b). Some storm lines, catch basins, and manholes could not be cleaned because of excess water in the system, blockage problems, obstructed access to catch basins or manholes,or the angle of the storm line. Approximately 90 percent of the manholes and 81 percent of the catch basins were cleaned; approximately 60 percent of the estimated 7 miles of piping was cleaned (Landau 1993b). A total of 130 cubic yards of dewatered soil (six 40-cubic yard drop boxes) were transported for disposal to a licensed Arlington, OR, facility for disposal as Toxic Substances Control Act (TSCA) regulated material. PCB concentrations in the soil samples ranged from 5.1 to 160 mg/kg (Landau 1993b). Wastewater was processed at the Boeing wastewater treatment plant and then discharged

[5] Note: Analytical results for a sample collected from MH-8B (MH-17-2) showed total PCBs of 1,240 mg/kg; however, a duplicate sample at this location (MH-17-3) contained 328 mg/kg. A sample at this location collected one month earlier (MH-17-1) contained 287 mg/kg total PCBs. The poor replication of results was attributed to sample inhomogeneity, small sample volumes, and dilution.

to the Metro sewer. PCBs in the water samples ranged from 8 to 280 ug/L. The cleanup of soils/sediments was completed on December 22, 1992.

- In a letter to Ecology on April 30, 1993 (Boeing 1993e), Boeing stated that no PCB transformers or PCB equipment were known to be in use at North Boeing Field at that time. Boeing claims that "there is no known evidence of Boeing PCB materials that could have been responsible for the concentrations found in the storm sewer system." (Boeing 1993e). Boeing suspects that some of the PCBs in the storm drain system may have migrated from the GTSP to Boeing-leased property (Boeing 1993e).
- In a letter to Ecology dated September 13, 1993, Boeing asserted that potential environmental impacts from any remaining soils/sediments in the storm system are minimal because migration pathways are limited to loose pipe joints and/or small cracks, PCBs were found in the sediments only (not in the water), and the physical characteristics of the sediments (i.e., grain size and density) would preclude movement of these sediments through small cracks or loose pipe joints (Boeing 1993h).
- Additional sampling was conducted in October 1996; September 1997; August 1998; March and May through August 2000; May/June 2005; September/October 2005; and January, March through June, and July 2006 (Bach 2006o).
- Storm drain samples collected during 1996 through August 1998 contained PCBs ranging from 0.25 to 234 mg/kg; the highest PCB concentrations were found in OWS-186[6] (234 mg/kg), CB370 (158 mg/kg), CB224 (145 mg/kg), and OWS-483B (110 mg/kg). Samples collected during 2000 contained PCBs ranging from 0.2 to 342 mg/kg; the highest PCB concentrations were found in MH-483A (342 mg/kg), CB584 (213 mg/kg), OWS-186 (199 mg/kg), CB228F (161 mg/kg), and CB384 (130 mg/kg). (Note that CB584 is no longer Boeing-leased property.)

2004

- In 2004, Boeing collected suspended solids from the King County lift station, which discharges to Slip 4 (Landau 2004). A filtration system was installed on the inlet side of the lift station; a 20-inch bag filter housing and 5-micron rated polypropylene felt filter bags were used. Two samples were collected: one during dry weather (afternoon of July 19 to morning of July 20, 2004), and the other during a period of light rainfall (morning of August 25 to afternoon of August 26, 2004). Filtration was discontinued in both cases when the filter was found to be clogged. A total of approximately 2,484 and 2,456 gallons, respectively, were collected during the two events. The filter bags were analyzed for PCBs. Aroclor 1254 was detected at concentrations of 76 to 270 ug per kg of filter fabric; Aroclor 1260 was detected in one of the samples at 120 ug per kg of filter fabric (Landau 2004). Based on these results, Landau Associates calculated total PCB concentrations in the filtered solids of 0.18 mg/kg and 1.18 mg/kg in the two samples. Using an average TOC value for Slip 4 surface sediments (3.2%), OC-normalized PCB concentrations of 6 mg/kg and 36 g/kg were calculated for the two filter samples (Landau 2004).

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[6] OWS-186 is also known as UBF-55.

- Additional filtration and PCB testing was conducted in November and December 2004, using the same methodology described above (Boeing 2005b). A sample from CB-178 contained 90 ug/kg filter material PCBs (Aroclor 1254); samples from CB-461 and CB-482 contained 40 ug/kg and 127 ug/kg filter material total PCBs, respectively (approximately equal proportion Aroclors 1254 and 1260). These values correspond to filtered solids concentrations of 0.30 mg/kg, 0.067 mg/kg, and 0.17 mg/kg total PCBs, respectively. OC-normalized concentrations ranged from 2.1 to 9 mg/kg PCBs (Boeing 2005b).

2005

- On February 16, 2005, SPU conducted a site visit to NBF, which included collection of inline storm drain sediment samples at the following manholes: MH-100, MH-221A, MH-229A, and MH-363 [22, 65]. Inline sediment samples are grab samples collected from sediment that has deposited in the storm drain line, typically at maintenance holes or other areas where sediment accumulates. Boeing collected split samples (Bach 2005a). MH-100 is located at the downstream end of the Georgetown flume, prior to draining under East Marginal Way. MH-221A is located on central lateral #2, one of the main drain lines serving the flight line areas. MH-229A is a storm line draining KCIA; it is upstream of MH-221A. MH-363 is an NBF storm drain line from the Propulsion Engineering Laboratories on the north end of NBF, along the north lateral storm drain line. PCBs were detected in all four manholes at concentrations ranging from 0.3 mg/kg (MH-221A) to 31 mg/kg (MH-363); OC-normalized PCB concentrations were 7.1 to 2,793 mg/kg OC (SPU and King County 2005b). Other detected analytes included arsenic (8 to 30 mg/kg), copper (45.1 to 102 mg/kg), lead (50 to 155 mg/kg), mercury (0.07 to 0.7 mg/kg), zinc (218 to 1,130 mg/kg), diesel range hydrocarbons (36 to 200 mg/kg), motor oil (140 to 1,100 mg/kg), and BEHP (0.43 to 2.2 mg/kg; 30 to 76 mg/kg OC). In addition, a variety of SVOCs were detected in MH-229A; these included carcinogenic PAHs (over 20 mg/kg total), noncarcinogenic PAHs, di-n-octyl phthalate, dibenzofuran, and carbazole (Bach 2005a).
- A flume sediment sample collected on March 25, 2005, adjacent to a 15-inch pipe entering the south side of the flume at the downstream end of the GTSP discharge tunnel contained 92 mg/kg (1,746 mg/kg OC) of PCBs (SPU and King County 2005b). This pipe drains the NBF site.
- An active 8-inch pipe draining from NBF into the flume approximately 790 feet from the upstream end of the flume was observed during a 2005 inspection of the flume (SPU and King County 2005b). This discharge is permitted at 100 gpm.
- In March 2005, SPU installed sediment traps at nine locations at NBF and KCIA, including locations along each of the main lateral storm drain lines passing through NBF (Figure 6) (SPU and King County 2005b). The following locations were sampled:
    - MH-422 (T1): 60-inch KC Airport SD#3/PS-44 EOF at the downstream end of the north and central laterals
    - MH-356 (T2) and MH-482 (T2A): 60-inch KC Airport SD#3/PS-44 EOF, south lateral (downstream and upstream of the Boeing leased property)

- MH-364 (T3) and MH-19C (T3A): 60-inch KC Airport SD#3/PS-44 EOF, central lateral#1 (downstream and upstream of the Boeing leased property)
- MH-221A (T4) and MH-229A (T4A): 60-inch KC Airport SD#3/PS-44 EOF, central lateral #2 (downstream and upstream of the Boeing lease property)
- MH-363 (T5) and MH-178 (T5A): KC Airport SD#3/PS-44 EOF, north lateral (downstream and upstream of the Boeing lease property)

Station locations were selected to isolate individual storm drains and subbasins within the larger Slip 4 drainage basin. Traps are installed for a 4- to 6-month period to passively collect samples of suspended sediment present in the stormwater runoff.

- In April 2005, another filter sample was collected at the King County lift station; 310 ug/kg filter of PCBs were detected; this corresponds to calculated PCB concentrations in filtered solids of 0.52 mg/kg dry weight (DW), or 16 mg/kg OC. This is within the range of the earlier samples (collected in July and August of 2004). Two additional samples, from CB-130 and CB-114, were collected in October 2005. Results indicated the presence of Aroclors 1248, 1254, and 1260; total PCBs ranged from 1,170 to 1,420 ug/kg filter material (Boeing 2005b). Calculated PCB concentrations in filtered solids were 2.2 mg/kg DW, 68.3 mg/kg OC in CB-130, and 1.4 mg/kg DW, 42.7 mg/kg OC in CB-114 (Boeing 2005b).
- During May and June 2005, 13 of these storm drain structures were sampled for PCBs. Twelve of these structures were identified for sampling due to elevated PCB detections discovered during prior sampling events. Sample results for the 12 structures from July and August 1991 to August 2000 had PCB detections ranging from 17 to 342 mg/kg [20, 21]. Results from May and June 2005 ranged from 3.5 to 50 mg/kg DW.
- In August 2005, SPU and Boeing removed and redeployed the traps for the winter wet season [22]. Chemicals that exceeded Sediment Management Standards include mercury, zinc, BEHP, and PCBs. Mercury concentrations (0.1–1.12 mg/kg DW) exceeded the CSL in three traps (T1, T5, and T5A) and zinc (220–553 mg/kg DW) exceeded the Sediment Quality Standards (SQS) in two traps (T4A and T5). TOC was not analyzed in all samples because of low sample volumes and so comparisons with Sediment Management Standards (SMS) for organic compounds could only be performed on two of the sediment trap samples (T1 and T4A). BEHP (49–189 mg/kg OC) exceeded the SMS in both samples.
- PCBs were detected in all nine traps at concentrations ranging from 0.04 to 24 mg/kg DW and exceeded the MTCA Method A cleanup level for residential soil of 1 mg/kg DW in five traps. As described above, TOC analysis was performed for only two samples, and therefore only these samples could be compared to the SMS. One of the two samples (T1, 233 mg/kg OC PCBs) exceeded the CSL for PCBs.
- During September 2005 through November 2005, Boeing conducted an investigation to determine the source of PCBs in the north storm drain line where PCBs were detected in sediment at 24 mg/kg DW. Samples were obtained from nine catch basins and PCBs were detected from 0.07 mg/kg to 1,310 mg/kg DW (Bach 2006o). The highest PCB concentrations were found in CB173 (1,310 mg/kg in September, 400 mg/kg in October).

In addition, filter bag samples were collected from CB173 (510 mg/kg), CB130, and CB114 (ARI 2005a).

- In order to determine whether infiltration of PCB-contaminated soil to storm drains from breaks or gaps in the piping system is occurring in the vicinity of CB-173 (the catch basin with 1,310 mg/kg DW PCB), Boeing removed accumulated sediment from the lines leading to this catch basin and conducted a video inspection. The system appeared to be in good condition with no visual gaps or breaks in the piping (Cargill 2005b). The line was last cleaned in 1992 (Bach 2005f). During an inspection to identify potential PCB sources, Boeing personnel observed soil entering the NBF drainage from the GTSP property; soil was entering the drainage system along gaps in the Jersey barrier retaining wall (near the location of the former low-lying area at GTSP) (Cargill 2005b).
- In addition, samples were collected from six manholes and two OWSs during this time period. Manhole sediment PCB concentrations ranged from 0.11 mg/kg to 84 mg/kg (in MH-193). Sediments in oil/water separators OWS-132 and OWS-186 contained 12 and 49 mg/kg PCBs, respectively (Boeing 2005b).
- In November 2005, Boeing collected soil samples from the gaps in the concrete retaining wall that parallels the storm drain line and the fence line between the GTSP and NBF. Concentrations were highest in the six samples collected along the southeast end of the property (5.1 to 2,400 mg/kg DW). PCB concentrations in the soil samples collected just south of the Steam Plant building were generally below 1 mg/kg DW. PCBs in these soils were predominantly Aroclor 1254. Boeing believes that this soil may be the source of the elevated PCBs in the NBF north end storm drain line (Bach 2005e).

2006

- During 2006, investigation efforts were focused on the evaluation of structures where PCBs had historically been detected at concentrations above 10 mg/kg. These samples showed PCBs ranging from 1.0 to 1,200 mg/kg, with highest detections in OWS-186 (1,200 mg/kg), MH-193 (191 mg/kg), and CB173 (110 mg/kg in March, 122 mg/kg in May) (Bach 2006n).
- In-line sediment traps were removed and sampled in March 2006 (Bach 2006f).
- Catch basin filters were installed on two catch basins (CB182 and CB185) along the storm drain line bordering the GTSP and NBF properties to limit potential infiltration into the catch basins during rainfall events. In March 2006, Boeing collected samples from these filters (Bach 2006c). Results showed Aroclor 1254 at concentrations of 14.0 and 5.5 mg/kg, respectively. In addition, Boeing resampled catch basin CB-173, which receives drainage from CB-182 and CB-185, as well as from other areas around Building 3-323 (Bach 2006d); sediment in this catch basin contained Aroclor 1254 at a concentration of 110 mg/kg (Bach 2006c). The samples from CB-182 and CB-185 consisted of solids obtained from catch basin filters that had been installed to prevent soil from entering the catch basins along the GTSP fenceline (Bach 2006d). These filters are not designed to capture fine particulates, so it is not clear how much of the PCB-contaminated particulates passed through these filters (Bach 2006d). The CB-173 sample was collected from the bottom of the manhole.

- On April 26, 2006, Boeing sampled storm drain lines leading to CB173 for PCBs [71, 72]. Samples were collected from the base of CB182 (6.1 mg/kg) and CB185 (11 mg/kg), the catch basins with insert filter fabric located near the GTSP. Results were similar to those from filter material samples collected previously, which indicates that fine soil particulates may be passing through the filters. A solids sample was collected from a 6-inch concrete pipe entering CB179 (34 mg/kg); this pipe enters CB179 from the north (parallel to the fence line) (Bach 2006e). One sample (labeled as CB173) was actually collected from the pipe leading from CB174 (29 mg/kg). An accumulation of dark fine sand had collected in this pipe. Groundwater appears to be infiltrating to this line from an unsealed pipe connection; the fine sand is likely being transported by that infiltration (Bach 2006e). A solids sample was also collected from CB175 (3.2 mg/kg), one of the other three influent sources to CB173.
- In May 2006, Seattle City Light conducted an interim soil cleanup action to remove PCB-contaminated soil near the fence line between the GTSP and NBF (SCL 2006). Boeing had installed a temporary sandbag dam on the 15-inch drain line at CB173 that receives drainage from MH-179, MH-179A, and the GTSP fence line catch basins. The dam allowed Boeing to collect a solids sample from CB173 prior to conducting a cleanout of the storm drain lines. This sample contained 122 mg/kg total PCBs (Bach 2006h).
- On May 31, immediately after Seattle City Light completed the interim soil cleanup action, Boeing cleaned the storm drain lines and catch basins flowing into CB173 (Bach 2006h). After the cleanout, two 6-inch storm drain lines entering MH-179 and MH-179A from the north were plugged; these drain lines appeared to be abandoned. Boeing collected samples from CB173 both before and after the cleanout (May 30, 2006, and June 22, 2006) [120, 121]. Approximately ½-inch of solids had accumulated since the cleanout on May 31. The results indicated the presence of total PCBs at 26 mg/kg. This was very similar to the April 26 result for the pipe leading from CB174 (see above). Based on this, Boeing postulates that groundwater infiltration to the unsealed pipe location may be transporting and contributing PCBs to CB173 (Bach 2006i). Boeing temporarily plugged and bypassed the line with the unsealed pipe connection; drainage would be re-routed directly from CB173 to CB174, with a sump pump installed in CB174. Boeing planned to clean CB173 again and later resample.
- Selected structures on the south drain line were sampled by Boeing in July 2006 (approximately 25 to 30 locations). BEHP was detected at concentrations ranging from 0.75 to 42 mg/kg. While none of the samples exceeded MTCA Cleanup Levels, BEHP concentrations in four of the structures exceeded the screening levels for protection of sediment: OWS-483B (42 mg/kg), MH-261 (26 mg/kg), OWS-1C (10 mg/kg), and CB446 (5.9 mg/kg). These samples exceeded the screening level of 1.6 mg/kg by factors of 26, 16, 6, and 4, respectively. Butylbenzyl phthalate, di-n-butyl phthalate, and di-n-octyl phthalate were also detected in several samples; the highest concentration was 34 mg/kg of di-n-octyl phthalate in OWS-1C. None of these results exceeded sediment screening levels.
- In July 2006, Boeing re-sampled storm drain structures that previously had PCB detections over 10 mg/kg sometime in the past; they also evaluated elevated phthalates in

the south drain line. PCBs in OWS-186 were detected at 1,200 mg/kg; in addition, elevated phthalates were discovered (Bach 2006l).

- Selected structures on the south drain line were also sampled for PAHs in July 2006. PAHs were detected in all seven samples. A sample collected from OWS-483B barely exceeded soil screening levels for sediment protection for phenanthrene, chrysene, and benzo(a)pyrene; a sample collected from MH-482 barely exceeded screening levels for indeno(1,2,3-cd)pyrene and benzo(g,h,i)perylene. In addition, all samples except MH-481 exceeded one or more MTCA Method B cleanup levels (unrestricted use) for carcinogenic PAHs.
- In August of 2006, Boeing cleaned out OWS-640 (Bach 2006j). This unit holds 20,000 gallons of water and has multiple sets of coalescing plates that were pressure washed. Water from the cleanout was processed, and the north storm drain line from CB173 to the lift station was scheduled to be cleaned out in late August. This cleanout included the following storm drain line segments plus at least 20 to 30 feet of any side drain lines that connect to manholes on this line (Bach 2006k):

  CB-173 to CB-172, 12-inch line, 40 feet
  CB-172 to CB-170, 24-inch line, 140 feet
  CB-170 to CB-163, 24-inch line, 80 feet
  CB-163 to CB-158, 24-inch line, 140 feet
  CB-158 to CB-152, 24-inch line, 40 feet
  CB-152 to CB-130, 24-inch line, 200 feet
  CB-130 to CB-112, 24-inch line, 210 feet
  CB-112 to CB-108, 30-inch line, 15 feet
  CB-108 to CB-108A, 30-inch line, 100 feet
  CB-108A to CB-363, 30-inch line, 110 feet
  CB-363 to CB-363A, 30-inch line, 85 feet
  CB-363A to CB-362, 36-inch line, 110 feet
  CB-362 to CB-358, 36-inch line, 200 feet
  CB-358 to CB-422, 36-inch line, 115 feet
  CB-422 to CB-421 (lift station), 42-inch line, 15 feet

  A total of approximately 500 feet of the north drain line were cleaned, including OWS-186 (which contained elevated PCBs), before reaching the capacity in the treatment system holding tanks [125, 128].

4.3.3.2 Summary of PCB Contamination in Storm Drains

Specific structures that have repeatedly shown significant concentrations of PCBs in sediment are discussed further below. Storm drain sampling results are summarized in Tables 3 and 4. Figure 11 identifies locations at NBF where PCBs have been detected in storm drains; Figure 13 depicts the most recent detected PCB concentrations in the northern portion of NBF. Figure 14 shows storm drain sampling locations on the northern end of NBF.

North Drain Line, CB-173 Area

CB-173: This catch basin is adjacent to the Georgetown Flume, to the south of the GTSP; it has been sampled nine times between July 1992 and June 2006. PCB concentrations have fluctuated from 12.8 mg/kg (in 1992) to 1,310 mg/kg (in September 2005). The most recent samples (May and June 2006) contained 122 mg/kg and 26 mg/kg PCBs, respectively. This catch basin was cleaned out in August 2006. In order to determine whether infiltration of PCB-contaminated soil to storm drains from breaks or gaps in the piping system is occurring in the vicinity of CB-173, Boeing removed accumulated sediment from the lines leading to this catch basin and conducted a video inspection. The system appeared to be in good condition with no visual gaps or breaks in the piping. The following structures are upgradient of CB-173: CB-174, CB-175, and MH-179A.

CB-174/CB-174A: CB-174A drains to CB-174, which drains to CB-173. These catch basins have been sampled once, in October 2005. PCB concentrations were 13.7 mg/kg and 7.2 mg/kg, respectively.

CB-175: This catch basin has been sampled twice, with relatively consistent PCB concentrations (2.9 mg/kg in October 2005 and 3.2 mg/kg in April 2006).

MH-179A/MH-179/CB-182/CB-185: CB-182 and CB-185 appear to be upstream of MH-179 and 179A. CB-182 has shown PCB concentrations ranging from 3.4 mg/kg (August 1998) to 19 mg/kg (July 1992); the most recent sample contained 6.1 mg/kg PCBs. These PCB concentrations have persisted, even after cleanout of the catch basin in November 2005. CB-185 contained 220 mg/kg PCBs in July 1992. More recent samples have shown much lower concentrations of PCBs (2.0 to 11 mg/kg); however, PCBs as high as 11 mg/kg continued to be present even after cleanout of this catch basin in November 2005. The most recent sample (July 2006) contained only 2 mg/kg PCBs. MH-179 samples ranged from 1.3 to 47 mg/kg PCBs; the highest detection of PCBs at this location occurred in the most recent sample, collected in July 2006. MH-179 drains to MH-179A, which has only been sampled once (3.7 mg/kg in September 2005).

Formerly;
NBF-55

North Drain Line, OWS-186 Area

OWS-186: This OWS is located near the corner of the GTSP property at NBF. PCBs are present in soils immediately surrounding this unit; according to Boeing personnel, this OWS appears to be unusual in that it is a steel underground tank (Bach 2006m). High concentrations of PCBs have been detected in this structure since it was first sampled in 1998. The PCB concentration in August 1998 was 234 mg/kg; although it decreased to a low of 33 mg/kg in May 2005, the most recent sample indicated 1,200 mg/kg PCBs.

Since the outflow from this unit is blocked, stormwater fills the separator and then backflows out of the inflow pipe. Although PCBs had been detected in this OWS previously, the 1,200 mg/kg concentration detected in July 2006 was significantly higher than previous detections (Bach 2006m). Boeing is planning to route the storm drain around this structure in the near future.

The following structures are upstream of OWS-186. MH-187 drains to this unit.

MH-187/MH-193/CB-193/CB-194: CB-193 and CB-194 both drain to MH-193, which subsequently drains to MH-187. CB-193 and CB-194 have consistently shown moderate levels of PCBs; concentrations in CB-193 ranged from 12.0 mg/kg (July 2006) to 16.5 mg/kg (October 2005). Concentrations in CB-194 have ranged from 14.1 mg/kg (October 2005) to 20.3 mg/kg (July 2006). These catch basins drain to MH-193, which has shown increasing PCB concentrations since it was first sampled in September 1997 (47 mg/kg). The most recent sample indicated a PCB concentration of 191 mg/kg in this unit. MH-193 drains to MH-187, which historically contained high PCB concentrations (180 mg/kg in July 1992). Although the most recent sample at this location contained only 9.2 mg/kg PCBs, this unit was not sampled in 2006. It appears likely that MH-193 is a source of PCBs to OWS-186.

North Drain Line Downstream of OWS-186:

OWS-132: This unit has shown PCB concentrations ranging from 7.0 mg/kg (October 1996) to 46.8 mg/kg (May 2000), with the most recent sample indicating 7.3 mg/kg PCBs (January 2006).

MH-130: This manhole has been sampled twice, with PCB concentrations significantly decreasing from the first sampling event (11 mg/kg in September 1997) to the most recent (2.3 mg/kg in September 2005).

CB-113: This catch basin is located to the east of Building 3-330. PCBs were found at 31.7 mg/kg in July 2000 and at 28 mg/kg in September 2005. In July of 2006, PCBs were not detected; however, the sample quantitation limit of 15 mg/kg makes it impossible to say that PCBs are no longer present. The catch basin was cleaned out in August 2006.

MH-108: This unit has been sampled twice. In August 1992, 426 mg/kg PCBs were detected in sediment from this manhole. In July 2006, the concentration was 6.6 mg/kg.

CB-224 and CB-225: These catch basins both showed high levels of PCBs in August 1998 (145 mg/kg and 82 mg/kg, respectively). Although these concentrations have decreased, PCBs continue to be detected. July 2006 samples contained 5.6 mg/kg and 27.9 mg/kg in CB-224 and CB-225, respectively. These catch basins were cleaned out in October/November 2005 (prior to the most recent sampling), thus indicating an ongoing source of PCBs.

Central Lateral #2

MH-226/OWS-226A: PCBs in these units have ranged from 15 mg/kg to 46 mg/kg. Although the most recent samples (July 2006) show decreased concentrations (15 mg/kg and 17.4 mg/kg in MH-226 and OWS-226A, respectively), PCBs continue to persist at this location.

CB-227/CB-372A/CB-372/MH-249/CB-228F: These units drain to MH-226/OWS-226A. CB-227 has been sampled once (July 2006); it contained 7.5 mg/kg PCBs. PCB concentrations in CB-372A have decreased from 51 mg/kg in June 2000 to 8.8 mg/kg in May 2005. It was cleaned out in October 2005. CB-372 continues to show PCBs even after cleanout in October 2005. Concentrations of PCBs were 45 mg/kg in June 2000 and 32.8 mg/kg in July 2006 (after cleanout). PCBs in MH-249 have decreased from a high of 91 mg/kg in June 2000 to the most recent sample, which shows 11.2 mg/kg (July 2006). Concentrations in CB-228F appear to be decreasing, from a high of 161 mg/kg in June 2000 to not detected at 3.5 mg/kg in July 2006. The catch basin was cleaned out in October 2005.

MH-247: This unit was sampled in 1992; at that time, three samples were collected and PCB concentrations ranged from 287 to 1,240 mg/kg. This manhole has not been resampled, and it is not known whether PCBs remain at this location.

Central Lateral #1

CB-370: PCB concentrations in this catch basin, which contained 158 mg/kg PCBs in August 1998, also appear to be decreasing (40 mg/kg in June 2000 and 28 mg/kg in July 2006). This catch basin has apparently not been cleaned out.

CB-364A: Concentrations in this catch basin appear to be decreasing from a high of 70 mg/kg in August 2000 to 5.5 mg/kg in July 2006. The catch basin was cleaned out in August 2006.

OWS-421/OWS-1C/CB-384: OWS-421 and OWS-1C contain relatively low concentrations of PCBs (3.0 and 2.2 mg/kg, respectively in 2006 samples). PCB concentrations in CB-384 have decreased from 130 mg/kg in August 2000 to 16 mg/kg in May 2005. It was last cleaned out in October 2005.

CB-420/OWS-472A: PCB concentrations in these units have appeared to decrease over time. The most recent samples show 8.4 mg/kg in CB-420 (July 2006) and 5.6 mg/kg in OWS-472A (January 2006). The catch basin was cleaned out in October 2005.

MH-415/CB-416/CB-418/CB-419: PCB concentrations persist in these units, although they have decreased over time. Concentrations were 17 to 42 mg/kg in July 2000; most recently (July 2006) they ranged from 6.2 to 14.6 mg/kg. The catch basins were cleaned out in October 2005.

4.3.4 Joint Material Removal

After an investigation at Boeing Everett indicated the presence of PCBs in the caulk material used to fill expansion joints, an investigation was initiated in October 2000 to characterize the extent of PCBs in material used to fill concrete expansion joints at NBF. PCBs were used in the manufacture of some joint materials as a plasticizer and to protect the caulk from ultraviolet light.

The NBF investigation consisted of the following phases:

- October/November 2000: Visual inspection of joint materials; collection of 48 joint material samples (including samples of each type of joint material); and analysis of each sample for PCBs (Landau 2001b).
- February 2001: Characterization of joint material types A, E, G, and H, by documenting their location, extent, and condition; examination of the area near each joint sample location with total PCBs above 50 mg/kg for possible spills; and identification of joint material types near storm drain system structures that have historically contained solid material with total PCBs above 10 mg/kg (Landau 2001a).

- April 2001: Evaluation of the variability of PCB concentrations in three types of concrete joint material by collecting 39 additional joint material samples (including blind field duplicates) (Landau 2001c).

In October 2000, Boeing conducted a visual inspection of the concrete expansion joints at NBF. Ten joint material types (designated A through J) were identified, based on observed physical properties. In November 2000, samples of each of the 10 types of joint material were collected (48 samples total) and analyzed for PCBs. One sample of Type A joint material contained 23,000 mg/kg PCBs; two samples of Type G joint material contained 35,300 and 50,000 mg/kg PCBs, respectively; and one sample of Type H joint material contained 164 mg/kg PCBs. All other samples contained less than 50 mg/kg PCBs (Landau 2001b).

The February 2001 focused investigation identified joints that contained material types A, E, G, and H as the primary material, and identified joints where remnants of these types of joint material were present. The remnants (referred to as residual joint material) were found in areas where joint material had been replaced, but some of the old material remained along the edges of joints filled with new material. No evidence of spills was observed around previous joint sample locations or storm drain structures with PCB concentrations above 50 mg/kg (Landau 2001a). One additional joint material type (K) and one subtype (C2) were also identified.

A total of 39 additional samples of primary and residual joint material were collected and analyzed for PCBs in April 2001. A summary of the 2000/2001 joint material sampling results is provided in Table 5. Maps of the distribution of the various joint material types and concentrations are provided in Landau 2001c.

The extent of Type A joint material was estimated to be about 3,500 linear feet. Eight samples of Type A joint material were collected and analyzed. PCBs were detected in six of the samples, with concentrations ranging from 0.78 to 79,000 mg/kg; the highest concentrations (23,000 to 79,000 mg/kg) were detected north of Building 3-369. About 1,060 linear feet of Type A joint material was present in this area (Landau 2001a). Lower concentrations of PCBs were also detected adjacent to Building 3-350 (49 mg/kg) and near stall B-5 (43 mg/kg).

Type G was found both as primary and residual material, located along the edges of concrete joints filled with another type of material (most often Type B) (Landau 2001a). Approximately 464 linear feet of primary Type G material was found in the northern portion of NBF (north of stall B-9). Residual Type G material was estimated to be present along 56,000 linear feet (10.7 miles) of joints (Landau 2001a). PCBs were detected in all 16 samples that were collected and analyzed, with concentrations ranging from 6.1 to 61,000 mg/kg. Fourteen of the samples had PCB concentrations greater than 1,000 mg/kg (Table 5). The volume or mass of residual Type G material was not estimated.

Type H joint material was found throughout NBF. The extent of concrete expansion joints filled with Type H material was estimated at 64,000 linear feet (12.1 miles) (Landau 2001a). In addition, residual Type H material was estimated to be present along 191,000 linear feet (36.2 miles) of joints. PCBs were detected in 20 of the 22 samples of this material that were collected and analyzed. Concentrations ranged from 0.54 to 2,240 mg/kg. Three of the samples had PCB concentrations above 100 mg/kg; the highest concentration (2,240 mg/kg) was found northeast of

Building 3-390, near stall A-6. Concentrations of 164 to 270 mg/kg were detected near the Georgetown Steam Plant fenceline, in the vicinity of the low-lying area where PCBs were detected during SCL sampling in 1984.

PCBs were detected in other joint material types at lower concentrations:

- Type B: 41.9 mg/kg adjacent to Building 3-350, near stall A-1; 4.3 mg/kg along the east side of NBF near stall B-2
- Type C: 13 mg/kg near Building 3-369; 2.7 mg/kg just north of Building 3-390
- Type D: 2.7 mg/kg near stall A-6
- Type E: 5.2 mg/kg in the northern portion of the site
- Type F: 3.1 mg/kg west of Building 3-369

All other PCB detections were in the range of 1 mg/kg or less.

A letter from Boeing to EPA's PCB Coordinator in September 2001 stated that Boeing had determined that approximately 500 linear feet of concrete joints with sealant that was manufactured with PCBs, and containing PCBs at concentrations greater than 50 mg/kg, was present at NBF (Boeing 2001). The letter indicated that Boeing planned to remove this material. Boeing also stated that approximately 57,000 linear feet of concrete joints with residual caulking of the same type were identified, and that this material did not show any signs of decay nor evidence that breakdown of the material would enter stormwater runoff (Boeing 2001). Boeing planned to remove this residual material as part of ongoing joint maintenance activities.

In August 2002, a work plan was prepared by Landau Associates, Inc. for the removal of both primary and residual concrete expansion joint material. This document indicated that 900 linear feet of primary joint material with PCB concentrations above 50 mg/kg had been identified, in addition to the 57,000 linear feet of residual material (ITC 2000). The primary joint material was scheduled for removal in 2002; residual joint materials with PCB concentrations above 50 mg/kg were scheduled for removal between 2003 and 2006.

The following procedures were used to remove the joint material:

- Cut along each side of the joint with a concrete saw.
- Remove by hand as much of the material as possible; the material was drummed for disposal as PCB-containing waste.
- Pressure wash to clean the slurry and debris out of the joint and from the top of the concrete surrounding the joint.
- If any joint material or residual joint material remained, a 6,000-psi pressure washer with a point tip and/or a diamond grinding wheel were used to scrape away all of the remaining joint material.
- Clean the concrete surface in the work area with a pressure washer, and remove any accumulated debris from the joint prior to refilling. Drum vacuums were used during

pressure washing to control and capture the wastewater, slurry, and debris. Brooms were also used to contain the material.

- Backfill the joints using a non-PCB containing sealant.

Removal of joint material was conducted between 2002 and 2006, as follows (Boeing 2005a, Landau 2006):

- August 2002: 900 linear feet of primary joint material
- 2003: 16,225 linear feet of residual joint material
- June through October 2004: 30,500 linear feet of residual joint material
- June through October 2005: 36,650 linear feet of residual joint material, plus 4,000 linear feet of joint material used to fill cracks in the concrete

Removal activities were conducted by Boeing Maintenance employees, with periodic observation and inspection by Landau Associates (Boeing 2005a). Inflatable plugs were placed in the discharge and inflow pipes of all catch basins within 25 feet of removal activities to minimize the potential for joint material to enter the stormwater system. Because removal activities were performed on days without significant precipitation, it was easy to monitor the surface runoff from removal activities. None of the surface water runoff entered the vicinity of any of the catch basins (Boeing 2005a).

All wastewater generated during the removal activities was contained and transferred to a temporary treatment system constructed at the north end of NBF. The treatment system consisted of a series of tanks, pumps, and filters that were used to separate suspended solids from water. The solids were disposed of at a TSCA-permitted landfill (Boeing 2005a). Water samples were collected and analyzed; if the concentration of PCBs was below the 1.45 ug/L discharge limit, it was discharged to the sanitary sewer. If PCB concentrations were above the discharge limit, the water was reprocessed through the treatment system until the PCB concentration was below the discharge limit. Other solid and hazardous waste generated during removal activities and decontamination activities were contained and labeled (Boeing 2005a).

Approximately 1,450 linear feet of residual joint material containing PCB concentrations greater than 50 mg/kg remained to be removed as of the end of 2005; removal of this material was planned for 2006 [69].

4.4 Potential for Sediment Recontamination

Based on the available information reviewed as part of this evaluation, several potential sources of contaminants that could contribute to recontamination of Slip 4 sediments were identified. These are listed below.

Ongoing Operations: NBF operates in compliance with applicable permits and has a good compliance history with regard to both industrial wastewater and stormwater permits. However, the most recent SWPPP that was available during this review was dated November 1997 (transmitted to Ecology in September 2001). Reportedly, Boeing is in the process of updating this document. To minimize the potential for releases to Slip 4 sediments from ongoing operations at NBF, an up-to-date SWPPP should be maintained. The potential for sediment recontamination due to ongoing operations at NBF are believed to be low.

Building 3-333: PCBs to 4,150 mg/kg were detected near the current location of Building 3-333; a broken pipe containing a black oily substance with over 25,000 mg/kg PCBs was found in this area in 1997. After remediation, residual PCB concentrations remained at the site. PCBs to 51 mg/kg remained on the east wall of the excavation. The bottom of the excavation, which was located below the water table, contained residual PCBs at 380 mg/kg. PCBs in soil and possibly groundwater at this location may be transported to the Georgetown flume or to nearby catch basins. Recent (2005) sampling of CB-209B, located to the south of Building 3-333, found very low PCB concentrations. This area is considered a potential source of sediment recontamination for Slip 4.

UBF-55 and UBF-27: PCBs were detected during removal of fuel storage tank UBF-27 in 1986; residual PCB concentrations were 15 to 43 mg/kg. Soil samples collected near the adjacent oil/water separator UBF-55 (currently known as OWS-186) in 1997 found PCBs to 1,540 mg/kg. No cleanup action was conducted. While the source of PCBs at this location is not known, PCBs have been present in soil and potentially groundwater in this area for at least 20 years. These areas are considered potential sources of sediment recontamination for Slip 4.

Other Historic Releases to Soil/Groundwater: Numerous environmental investigations have been conducted at NBF over the years. Many related to petroleum hydrocarbon and solvent releases related to aircraft maintenance and delivery activities. While PAHs, phthalates, metals, and other contaminants have been detected at some of these sites, these chemicals are believed to pose a much lower sediment recontamination risk than do PCBs. These areas are considered a minor potential source of sediment recontamination for Slip 4.

Storm Drain System: Overall, PCB concentrations in the storm drain system at NBF have been decreasing since efforts to sample and clean out storm drain piping and structures was begun. Despite significant efforts to clean the storm drain system; however, PCBs continue to be detected at high concentrations in catch basins, manholes, and OWSs. During 2005/2006, PCBs were detected at concentrations over 100 mg/kg in CB-173, MH-193, and OWS-186; the concentration in OWS-186 was 1,200 mg/kg in July 2006. These levels of PCBs in the storm drain system continue to pose a significant potential source of sediment recontamination for Slip 4.

Joint Material: Boeing has removed concrete joint material containing PCB concentrations above 50 mg/kg. However, it is likely that PCBs are continuing to enter the storm drain system due to the deterioration of joint material containing less than 50 mg/kg. The remaining PCB-containing joint material is believed to be a potential source of sediment recontamination for Slip 4.

5.0 Adjacent Properties

5.1 King County International Airport

King County International Airport (KCIA) is a general aviation airport owned and operated by King County as a public utility. The site covers about 615 acres (including the Boeing-leased area), of which 435 acres are impervious surface covered by buildings and paved areas. The remaining 180 acres consist of grass and landscaped areas (Ecology 2006).

5.1.1 Current Operations

According to the KCIA 2001 Master Plan, the facility consists of two runways, an extensive system of taxiways, aircraft parking aprons, industrial aviation facilities, hangars, commercial aviation business facilities, a terminal building, and various other airport facilities (KCIA 2001).

The main runway (13R/31L) is 10,000 feet in length and 200 feet in width; the secondary runway (13L/31R) is 3,710 feet in length and 100 feet in width. Both are constructed of asphaltic concrete and Portland cement concrete (KCIA 2001). The runways have full-length parallel taxiway systems, as well as a system of exit taxiways (allowing airplanes to exit the runways) and connecting taxiways (providing access to aircraft parking and hangar areas).

On the west side of the airport, the northern aircraft parking apron areas are occupied by Boeing, while the southern apron areas are utilized by general aviation aircraft. On the east side of the airport, the aprons north of the terminal building are used for general aviation aircraft parking, while south of the terminal, the aprons are used by air cargo and general aviation operators (KCIA 2001).

Commercial aviation operators located on the east side of KCIA include Classic Helicopter, King County Jet Center, Galvin Flying Service, Boeing Business Jets, Flightcenter, Aeroflight, and Wings Aloft. Numerous general aviation aircraft storage hangars are also located on the east side of the airport. The Terminal Building is centrally located on the east side of the aiport; it is a two-story structure originally constructed in 1930. Connected to the Terminal Building on the south is a 38,000-square foot Arrivals Building, constructed in 1978. Five parking lots are located near the Terminal Building; additional parking is associated with leased properties.

The airport's main fuel storage facility is located on the north end of KCIA property; the facility is privately owned by a company that leases storage in the tanks to the fixed base operators at the airport. It consists of 10 20,000-gallon underground storage tanks (seven jet fuel tanks and three aviation gasoline tanks). As of 2001, the facility was located within the Runway 13R protection zone and was scheduled for relocation (KCIA 2001).

The airport's airfield maintenance facility is located in the northwest corner of the airport in a 51,840-square foot building. The air traffic control tower is located mid-field, on the west side of the airport. An Aircraft Rescue and Fire Fighting (ARFF) facility is located adjacent to the tower

An area on the northwest corner of airport property does not have taxiway access and is therefore dominated by non-aviation uses: Washington Air National Guard, a landscape nursery, a soil distributor, airport maintenance, and the Federal Aviation Administration (FAA) Flight Service Station.

5.1.1.1 Current Site Drainage

There are about 15 miles of pipe in the airport storm drainage system. All stormwater discharges into the Duwamish Waterway. There are two pumping stations, which lift the water and pump it out at two outfalls. The north pump station discharges to Slip 4. The southern pump station drains the central portion of the airport through a 48-inch pipe that runs under Boeing property and discharges to the Duwamish Waterway at river mile 3.8.

There are two gravity lines that drain the south end of the airport. One discharges into Slip 6 and the other discharges into the storm drain portion of the Norfolk CSO/SD located at river mile 4.9. Between one and two acres of the north airport drainage are connected to the I-5 Storm Drain (King County 2003).

Approximately 171 acres of KCIA discharge to Slip 4 via KC Airport SD#3/PS-44 EOF. This drainage includes portions of the Air National Guard facility, the KCIA maintenance shop, areas at the northern end of the airport including parts of the runways and taxiways, a KCIA fuel station, the small airplane parking areas and hangars adjacent to the East Perimeter Road, the terminal, north annex, and administration buildings (King County 2003).

The airport has an NPDES Industrial Stormwater Permit (SO 3000343D), effective September 20, 2002, and expiring on September 20, 2007. The airport has a SWPPP, which addresses the airport maintenance facilities and the paved areas (runways and taxiways). Other businesses at the airport are covered under individual permits.

The airport maintenance shop is located at the northwest corner of the airport. A portion of this area drains into the I-5 storm drain after passing through an OWS. The remainder of the site drains to the northwest pump house and is discharged to Slip 4. Each OWS is inspected weekly (King County 2003).

Sampling for the maintenance shop facility is performed quarterly. The sampling location represents the maintenance facility and includes the runoff from the bulk storage and equipment storage areas (King County 2003).

Almost all of the stormwater runoff generated on the airport (excluding the Boeing-leased area) is treated in gravity OWSs. Two of the separators also contain two coalescing plate oil separators. In addition, in the more recent site development, the airport has installed advanced treatment systems including vortex treatment and a storm filter system utilizing compost filtration canisters. Each OWS is inspected weekly (King County 2003).

5.1.1.2 Potential Industrial Pollutant Sources

Airport Maintenance Shop

The activities at the airport maintenance shop include: storage and handling of various maintenance-related materials; fuel storage and vehicle fueling; vehicle and equipment maintenance; and repair and storage of vehicles and equipment.

Most vehicle and equipment maintenance and repair work is performed inside the auto shop. However, some of the larger equipment is occasionally worked on outdoors. The two 1,000-gallon aboveground fuel storage tanks (unleaded gasoline and diesel) are uncovered. The tanks have a 7-gallon overfill containment feature for spill protection during filling. The tanks are double lined with a monitoring tube to detect if the primary tank has leaked.

All liquid wastes are stored in a covered and contained area. Any spills associated with fueling would be contained according to the airport's spill procedures.

Deicing Activities

Deicing and anti-icing are performed on aircraft to minimize the ice buildup on the wings and plane body during cold weather conditions. A limited amount of deicing materials is used at the airport. Several tenants perform limited aircraft deicing. The airport has constructed dedicated areas for aircraft deicing. The runoff from these areas is diverted to the sanitary sewer system and is conveyed to the local municipal treatment facilities. All tenants are required to deice aircraft in the specified locations to prevent deicing fluids from entering the airport's stormwater system.

The airport's principal runway and Alpha Taxiway are occasionally deiced with potassium acetate during snow and ice events. A maximum of 81 acres may be deiced.

Airport Tenants

The activities of airport tenants include fuel storage and maintenance of aircraft, vehicles, and equipment, and repair and storage of vehicles and equipment. Most vehicle and equipment maintenance and repair work is performed inside hangars; however, some is performed outside.

Beginning in June 2004, 28 airport tenants (not including Boeing facilities) were screened as potential sources of contamination by SPU (Table 8). SPU found the operations at eight facilities were not potential sources of contaminants. The remaining 20 were inspected for compliance with stormwater, industrial waste, and hazardous waste handling requirements. As of December 2005, all but three of the facilities were in compliance. SPU is continuing to work to bring these facilities into compliance (SPU and King County 2004, 2005a, 2005b).

Galvin Flying Service is the only airport tenant in the Slip 4 drainage with an NPDES industrial stormwater permit (SO3000607D), effective September 20, 2002, and expiring on September 20, 2007. The facility has a SWPPP. Galvin Flying Service was inspected in 2004 and is currently in compliance.

Include Aviation Fuel Storage

5.1.2 History

The airport is the site of the homes of the original settlers who arrived in King County. In the early 1900s, the winding course of the Duwamish River, which ran through much of the airport property, was straightened and filled.

Construction of the airport began in 1928. The airport served as the community's aviation center until December 6, 1941, when the U.S. Army took over the airport for strategic and production reasons. The airport remained under military jurisdiction through the end of World War II.

In the late 1940s, the airport was reopened for passenger and other commercial traffic. Usage evolved to general aviation, serving industrial, business, and recreational purposes with the opening of Sea-Tac International Airport in 1947 (Global Security 2006).

In 1961, Boeing was allowed to use an area at the north end of KCIA for fire drill training (located east of the steam plant property). This area is referred to as the North Boeing Field Fire Training Center and is discussed further in Section 5.1.3. It was used for fire training activities from 1961 to 1991. In 1963, King County purchased the northwestern portion of the GTSP property, which included the NBF Fire Training Center, a large concrete oil storage tank, a warehouse, and a machinery shop (Bridgewater Group 2000).

On February 27, 1987, a fuel spill occurred during a routine Avgas truck refill at Galvin Flying Service, located at the northeast corner of Boeing Field [211, 212]. An employee pulled away from the filling station without disconnecting the storage refilling hose; this broke a weld in the truck at the refill adapter, resulting in an uncontrollable leak. Approximately 450 to 500 gallons of Avgas were spilled, most of which was contained or was evaporated. Crowley Environmental Services emptied the containment basin and vacuumed the area. An unknown quantity of fuel flowed to a nearby storm drain (Ecology 1987a).

In July 1988, Boeing requested permission from Ecology to transfer groundwater from dewatering of the Apron A6 area (northeast portion of NBF) to King County-owned pasture land on the KCIA site (Boeing 1988c). Approximately 9,000 gallons were to be discharged on the first day, and 400 to 500 gallons per day for five weeks thereafter. Samples of the discharge water were collected on July 11 (low concentrations of chromium, copper, and zinc, plus acetone at 13 ug/L and methylene chloride at 9 ug/L) and July 21 (low concentrations of cadmium, chromium, copper, nickel, and zinc, plus oil and grease at 35.3 mg/L). A handwritten note indicates that Ecology had approved the discharge and a letter would be sent (Boeing 1988c).

During 1995 to 1996, King County expanded its airport operations onto the GTSP site, including placement of soil piles on GTSP property (Bridgewater Group 2000); the piles were later graded by SCL.

A 1998 incident report indicates that 300 to 600 gallons of jet fuel were spilled at the Galvin Flying Services facility at the north end of NBF. Spilled material was trapped in the storm drain system and was recovered (Ecology 1998b).

5.1.3 Environmental Investigations and Cleanups

NBF-Fire Training Center (NBF-FTC) (1992–1993)

The NBF Fire Training Facility was used by Boeing fire personnel, as well as others, in training for aviation-related fires since the early 1960s (Boeing 1992k). The site is located on KCIA property at the north end of the airport runway. Boeing had negotiated an easement with KCIA for use of this property for fire training purposes. Although the easement expired in 1986, Boeing continued to use this facility for training exercises until late 1991 (Boeing 1992k).

An investigation conducted by Shannon & Wilson for Boeing (report dated July 12, 1983; not in file) identified a release resulting from training activities associated with this facility. Ecology allowed Boeing to continue use of the facility for fire training exercises after reviewing the report (Boeing 1992k).

In a letter dated December 16, 1992, Boeing transmitted a copy of the Soil and Groundwater Investigation Report for the NBF Fire Training Facility [164; report not in file]. Results of soil and groundwater sampling in 1992 indicated that petroleum hydrocarbon levels in some soil samples exceeded MTCA Method A cleanup levels. Impacts were limited to the boundaries of the fire training pit and an area near the catchment basins designed to contain runoff from training activities. Ecology indicated they would make a preliminary evaluation as to whether further action is required at this time under MTCA (Ecology 1992e).

A letter dated August 18, 1993, from Boeing to Ecology describes an independent remedial action conducted at the NBF Fire Training Facility (Boeing 1993g). This letter refers to excavation of petroleum-impacted soil and potential groundwater contamination.

A State Environmental Policy Act (SEPA) determination of nonsignificance was issued by King County Department of Development and Environment Services (KCDDES) on May 4, 1993, for excavation and onsite thermal treatment of approximately 4,000 cubic yards of contaminated soils located at the closed fire training facility (King County 1993). Associated catchment basins, piping, soil, and a fuel storage tank were also scheduled to be removed.

Ecology had several objections to the determination of nonsignificance (Ecology 1993), including the following:

- Characterization of the southeast catch basin was not addressed in Boeing's proposal. There is a potential that the catch basin has been impacted by activities at the fire pit, and remediation of sediments should be dealt with.
- Final cleanup verification should be conducted for contaminants other than TPH, including VOCs.
- The cleanup plan does not reference the status of the stormwater drainage line, which runs east parallel to the access road and west of the proposed excavation area for the fire pit. This drainage line was contaminated with PCBs originating from the Georgetown Steam Plant facility 200 feet to the northwest of the proposed excavation. The condition of the soil surrounding the line in the vicinity of the excavation needs to be evaluated.

The report identified above (Landau 1993c), dated August 5, 1993, describes removal of an underground storage tank located near the North Boeing Field Fire Training Center, approximately 1,000 feet north-northwest of the north end of the King County Airport main runway, and 200 feet southeast of a non-operating Seattle City Light power station (Landau 1993c). A shallow, geotextile fabric-lined ditch was located about 60 feet to the south of the UST. The tank was a 3,000-gallon fiberglass double-walled tank, installed in approximately 1986 (Landau 1993c). It contained jet fuel which was dispensed from a pumping station located above the tank on a concrete slab. The jet fuel was used during training exercises at the nearby former fire training center (Landau 1993c).

No visual signs of petroleum contamination were observed during removal of the tank or excavation of surrounding soil on June 4, 1993. Sidewall and stockpile soil samples were collected and analyzed for TPH-D; all results were below the detection limit of 25 mg/kg.

5.1.4 Storm Drain System

KCIA has been cleaning out accumulated solids from each catch basin on the airport semi-annually. Each OWS is cleaned annually, or more frequently if there are any accumulations noted during the weekly inspections.

KCIA video-inspected the majority of the airport's stormwater drainage system in 2001. The intent was to inventory the conditions of the system and to identify illicit sanitary connections to the stormwater drainage system. One sink discharge was identified and was subsequently diverted to the sanitary sewer system (King County 2006a).

Two contaminated site cleanups have been conducted within the area of the airport that drains to Slip 4: American Avionics (located at 7023 Perimeter Rd. S.) and King County Airport Maintenance (located at 6518 Ellis Ave. S.). Additional information is provided in the Property Summaries prepared by SAIC for these two facilities.

All of the tenants at the King County International Airport with operations that pose a threat of a release to Slip 4 have been inspected. SPU is working to bring the last three of 20 facilities into compliance (Ecology 2006).

In June 2006, KCIA conducted stormwater vault sampling at eight locations (Renaud 2006). Samples were analyzed for PCBs, SVOC, metals, TPH, and TOC. Results are listed in Table 6. PCBs were detected in seven of the eight stormwater vaults, with total PCB concentrations ranging from 0.24 to 1.9 mg/kg (Renaud 2006).

Concentrations of other analytes were generally highest in Vault 1757, located to the southeast of NBF. Analytes detected in the vault sediment samples include PAHs, phthalates, metals, and TPH (Tiffany 2006a). Total low molecular polycyclic aromatic hydrocarbon (LPAH) ranged from 0.77 mg/kg to 53.6 mg/kg in Vault 1757. LPAHs detected were acenaphthene (<0.82 to 1.0 mg/kg), anthracene (0.0.47 to 6.4 mg/kg), fluorene (<1.5 to 1.7 mg/kg), and phenanthrene (3.3 to 47.2 mg/kg). Total high molecular polycyclic aromatic hydrocarbon (HPAH) ranged from 9.4 mg/kg to 629.9 mg/kg, with the highest concentrations again in Vault 1757. HPAHs detected were: benzo(a)anthracene (2.2 to 35.5 mg/kg), benzo(a)pyrene (2.8 to 50.0 mg/kg), benzo(b)fluoranthene (4.5 to 83.2 mg/kg), benzo(k)fluoranthene (3.3 to 58.9 mg/kg), benzo(g,h,i)perylene (3.1 to 44.8 mg/kg), chrysene (4.7 to 70.1 mg/kg), dibenzo(a,h)anthracene (<0.82 to 12.9 mg/kg), fluoranthene (7.4 to 132 mg/kg), indeno(1,2,3-cd)pyrene (2.6 to 42.5 mg/kg), and pyrene (6.8 to 100.0 mg/kg).

Phthalates were detected in all eight vault samples, including bis(2-ethylhexyl)phthalate (29.4 to 232 mg/kg), butylbenzylphthalate (<0.7 to 4.1 mg/kg), and di-n-butylphthalate (<0.42 to 3.15 mg/kg). Highest phthalate concentrations were found in Vault 1757. Metals in the vault sediment samples included arsenic (9.3 to 34.4 mg/kg), copper (204 to 1,550 mg/kg), lead (190 to 744 mg/kg), mercury (0.13 to 0.54 mg/kg), and zinc (574 to 1,880 mg/kg). In addition, TPH was detected at concentrations above MTCA Method A cleanup levels (diesel ND to 16,000 mg/kg, motor oil 3,500 to 81,000 mg/kg).

In addition, coprostanol, which is associated with sewage, was detected in vaults 1541 and 1640, located on the north side of KCIA. These may be associated with the King County Maintenance Facility where trucks used to haul biosolids are washed and parked [127, 129]. The biosolids truck washing operation is tributary to Vault 1541; since coprostanol was also detected at Vault 1640, there may be a sanitary sewer connection to the vault in these sub-basins (Tiffany 2006b).

Comparison of organic-carbon normalized results to CSLs indicates that copper, lead, zinc, phenanthrene, all HPAHs, BEHP, and butylbenzylphthalate exceed their respective CSLs in one or more stormwater vault sediment samples. In addition, mercury, acenaphthene, acenaphthylene, fluorene, 2-methylnaphthalene, naphthalene, and total PCBs exceed their respective SQS values in at least one sample (Tiffany 2006a).

5.2 Other Adjacent Properties

KCIA tenant facilities also adjoin the NBF/GTSP site, including the Washington Air National Guard and Washington State Department of Transportation facilities located to the west, and the King County truck maintenance facility located to the northwest of the site. Twenty eight KCIA tenant facilities have been inspected by SPU/King County business inspection teams; as of December 2005, all but three of the facilities were in compliance with stormwater, industrial waste, and hazardous waste handling requirements (Ecology 2006). SPU is continuing to work to bring these facilities into compliance.

5.3 Potential for Sediment Recontamination

No significant issues with regard to potential sediment recontamination associated with current or historic operations at KCIA have been identified.

6.0 Potential Sources of Sediment Recontamination

Based on a review of existing documents, the following potential sources of Slip 4 sediment recontamination were identified:

Facility	Source
NBF – Storm Drain System	Recurring presence of high levels of PCBs in storm drain structures
GTSP – Low-Lying Area	Residual PCBs in soil and groundwater
NBF – UBF-55/UBF-27 Area	Residual PCBs in soil and possibly groundwater
NBF – Building 3-333 Area	Residual PCBs in soil and possibly groundwater
NBF – Joint Material	Presence of residual joint material with PCB concentrations to 50 mg/kg
NBF – Other Historic Releases	Potentially unidentified releases
KCIA – Joint Material	Possible use of PCB-containing joint material

Data gaps include information on the magnitude and extent of residual PCB contamination in soil and groundwater in the GTSP low-lying area and nearby locations at NBF, including the UBF-55/UBF-27 area. In addition, the magnitude and extent of residual PCB contamination near current Building 3-333 is considered a data gap. These areas may be contributing PCBs to Slip 4 via the storm drain system and Georgetown flume.

The continuing presence of PCBs in NBF storm drains may be related to the residual contamination identified above; however, given the sporadic nature of high PCB detections in the storm drain system, and the relatively widespread presence of PCBs in the system, it is likely that other sources of PCBs exist. The possibility of other PCB sources continues to represent a data gap. Regular cleanout of the storm drain structures will help to mitigate this potential.

Whether residual joint material at NBF contributes to PCB concentrations in the storm drain system is unknown.

7.0 Documents Reviewed

AB Consulting, Inc. 1986. Seattle City Light Georgetown Steam Plant, Soil Excavation and Sewerline Cleaning, Summary of Sampling and Analyses, October through December 1985. February 3, 1986. [54]

AGI (AGI Technologies). 1998a. Remedial Action Report, Proposed West Wing 3-333 Building Fuel Test Laboratory, North Boeing Field, Seattle, Washington. Prepared for The Boeing Company. January 8, 1998. [87]

AGI. 1998b. Site Investigation, Oil/Water Separator UBF-55, North Boeing Field, Seattle, Washington. Prepared for The Boeing Company. January 8, 1998. [88]

ASME (American Society of Mechanical Engineers). 1980. Georgetown Steam Plant, National Historic Mechanical Engineering Landmark, Dedication Program. May 7, 1980. [28]

ARI (Analytical Resources, Incorporated). 2005a. Analytical Results for Project: NBF 025082 (Filter); ARI Job: IT45. December 5, 2005. [13]

ARI. 2005b. Analytical Results for Project: Source Evaluation NBF 025082.093, November 2005; ARI Job: IT66. December 5, 2005. [14]

ARI. 2006. Analytical Results for Project: NBF PCB Investigation / 025082; ARI Job: JH28. May 2, 2006. [72]

Bach. 2005a. Email from Carl Bach, Boeing, to Dan Cargill, Ecology, RE: North Boeing Field Storm Drain Sample Results. April 8, 2005. [1]

Bach. 2005b. Email from Carl Bach, Boeing, to Beth Schmoyer, SPU, RE: Storm Drain Analytical Data. September 16, 2005. [22]

Bach. 2005c. Email from Carl Bach, Boeing, to Dan Cargill, Ecology, RE: Catch Basin Data. October 21, 2005. [20]

Bach. 2005d. Email from Carl Bach, Boeing, to Dan Cargill, Ecology, RE: NBF May & June Catch Basin Data. October 21, 2005. [21]

Bach. 2005e. Email from Carl Bach, Boeing, to Dan Cargill, Ecology, RE: North Boeing Field Source Control Investigation. December 5, 2005. [12]

Bach. 2005f. Email from Carl Bach, Boeing, to Dan Cargill, Ecology, RE: NBF Sample Location Figure. December 7, 2005. [16]

Bach. 2005g. Email from Carl Bach, Boeing, to Dan Cargill, Ecology, RE: NBF Sample Location Figure. December 8, 2005. [17]

Bach. 2005h. Email from Carl Bach, Boeing, to Dan Cargill, Ecology, RE: 1992 Storm Drain Cleaning Report. December 20, 2005. [18]

Bach. 2006a. Email from Carl Bach, Boeing, to Dan Cargill, Ecology, RE: 1992 Storm Drain Cleaning Report. January 6, 2006. [19]

Bach. 2006b. Email from Carl Bach, Boeing, to Dan Cargill, Ecology, RE: North Boeing Field Flume Re-Routing. March 8, 2006. [115]

Bach. 2006c. Email from Carl Bach, Boeing, to Wanda Schulze, SCL, RE: Georgetown Steam Plant. April 6, 2006. [64]

Bach. 2006d. Email from Carl Bach, Boeing, to Dan Cargill, Ecology, RE: Catch Basin Filters. April 20, 2006. [116]

Bach. 2006e. Email from Carl Bach, Boeing, to Dan Cargill, Ecology, RE: Sampling Results of Filter Solids – JH28 NBF PCB Investigation. May 4, 2006. [71]

Bach. 2006f. Email from Carl Bach, Boeing, to Dan Cargill, Ecology, RE: Updated sediment trap table. May 4, 2006. [73]

Bach. 2006g. Email from Carl Bach, Boeing, to Dan Cargill, Ecology, RE: 1954 NBF Drawing. May 8, 2006. [74]

Bach. 2006h. Email from Carl Bach, Boeing, to Dan Cargill, Ecology, RE: North drain line adjacent to City Light. June 20, 2006. [120]

Bach. 2006i. Email from Carl Bach, Boeing, to Dan Cargill, Ecology, RE: Manhole CB-173. June 28, 2006. [121]

Bach. 2006j. Email from Carl Bach, Boeing, to Dan Cargill, Ecology, RE: North Boeing Field Source Control Update. August 18, 2006. [124]

Bach. 2006k. Email from Carl Bach, Boeing, to Dan Cargill, Ecology, RE: North Boeing Field Source Control Update. August 21, 2006. [125]

Bach. 2006l. Email from Carl Bach, Boeing, to Dan Cargill, Ecology, RE: June 2006 SW Vault Sediment Sampling Data. August 25, 2006. [128]

Bach. 2006m. Email from Carl Bach, Boeing, to Dan Cargill, Ecology, RE: Oil/Water Separator 186. August 25, 2006. [130]

Bach. 2006n. Email from Carl Bach, Boeing, to Dan Cargill, Ecology, RE: North Boeing Field Storm Drain Sampling Results. September 8, 2006. [131]

Bach. 2006o. Email from Carl Bach, Boeing, to Dan Cargill, Ecology, RE: NBF – Additional PCB Sample. September 20, 2006. [132]

Boeing. 1983. Letter from W.R. Diefenderfer, Boeing, to Douglas A. Hilderbrand, Industrial Waste Supervisor, RE: PCB Contamination in City Light Flume. April 25, 1983. [98]

Boeing. 1984a. Map showing August 1984 PCB sampling results – North Boeing Field. September 5, 1984. [234]

Boeing. 1984b. Letter from Kirk J. Thomson, The Boeing Company, to M. Partridge, Environmental Protection Agency, RE: Tabulation of Specific PCB Aroclors. October 30, 1984. [61]

Boeing. 1985. Letter from W.R. Diefenderfer, Facilities Plant Engineering, Boeing Commercial Airplane Company, to Joan K. Thomas, Washington State Department of Ecology, RE: NPDES Stormwater Discharge Permit Applications. April 23, 1985. [193]

Boeing. 1986a. Letter from Clyde R. Cherberg, Boeing Commercial Airplane Company, to Joan K. Thomas, Washington State Department of Ecology, RE: Request for Renewal and Revisions to Permit WA-000086-8. February 7, 1986. [203]

Boeing. 1986b. Letter from David Smukowski, The Boeing Company, to Tim Samples (METRO) and Dan Cargill (Ecology), RE: Summary of investigations and conclusions of contamination in storm sewers at King County Airport and adjacent areas. March 6, 1986. [55]

Boeing. 1986c. Letter from Clyde R. Cherberg, Boeing Commercial Airplane Company, to Norman D. Peck, Washington State Department of Ecology, RE: North Boeing Field Spill Report. March 31, 1986. [204]

Boeing. 1986d. Letter from Mary Jane McGarity, The Boeing Company, to Dan Cargill, Department of Ecology, RE: PCB-Contaminated Soils at North Boeing Field. May 27, 1986. [205]

Boeing. 1986e. Letter from James L. Wooten, Boeing Commercial Airplane Company, to Norman D. Peck, Washington State Department of Ecology, RE: North Boeing Field Spill Report. June 3, 1986. [207]

Boeing. 1986f. Letter from David Smukowski, The Boeing Company, to Dan Cargill, Department of Ecology, RE: May 27, 1986 Letter from M. McGarity to D. Cargill. July 16, 1986. [206]

Boeing. 1986g. Letter from David Smukowski, The Boeing Company, to Dan Cargill, Department of Ecology, RE: Your 29 July 86 letter to D. Smukowski. August 22, 1986. [209]

Boeing. 1986h. Letter from David Smukowski, The Boeing Company, to Tim Samples, METRO, RE: PCB results for sediment samples. December 22, 1986. [59]

Boeing. 1987a. Letter from James L. Wooten, Boeing Commercial Airplane Company, to Norm Peck, Department of Ecology, RE: Closure of Hydrocarbon Recovery Well System at The Fuel Test Facility on North Boeing Field. February 9, 1987. [210]

Boeing. 1987b. Letter from Clyde R. Cherberg, Boeing Commercial Airplane Company, to Norman D. Peck, Department of Ecology, RE: Re-Routing of Compression Cooling Water, North Boeing Field. May 27, 1987. [213]

Boeing. 1988a. Letter from Clyde R. Cherberg, Boeing Commercial Airplanes, to Norm Peck, Washington State Department of Ecology, RE: Renewal of NPDES Permit WA-000086-8 Boeing, North Boeing Field. June 15, 1988. [192]

Boeing. 1988b. Letter from Clyde R. Cherberg, Boeing, to Norman D. Peck, State of Washington Department of Ecology, RE: Asphalt Emulsion Discharge to Storm System at North Boeing Field. June 21, 1988. [240]

Boeing. 1988c. Facsimile from Tom Grime, Boeing Commercial Airplane Co., RE: Request approval to transfer groundwater to pasture land. July 27, 1988. [216]

Boeing. 1989a. Letter from Clyde R. Cherberg, Boeing Commercial Airplanes, to Lynn Coleman, Washington State Department of Ecology, RE: Removal and Replacement of 3 Underground Tanks. January 31, 1989. [218]

Boeing. 1989b. Letter from Clyde R. Cherberg, Boeing Commercial Airplanes, to Pam Elardo, Washington State Department of Ecology, RE: Drawing of Outfalls 1 and 2, Renewal of NPDES Permit No. WA-000086-8, North Boeing Field. May 30, 1989. [201]

Boeing. 1989c. Letter from L.M. Babich III, Boeing, to Pam Elardo, Washington State Department of Ecology, RE: Comments to Proposed Draft NPDES Permit No. WA-000086-8. September 12, 1989. [198]

Boeing. 1989d. Letter from Guy Bruno, Boeing, to Joseph Hickey, Department of Ecology, RE: Underground Storage Tank (Tank X) – North Boeing Field. October 3, 1989. [142]

Boeing. 1989e. Letter from Guy Bruno, Boeing, to Joseph Hickey, Department of Ecology, RE: Report of Underground Tank Discovery, 300 Gallon Steel at North Boeing Field. November 21, 1989. [141]

Boeing. 1990a. Letter from Cynthia J. Lees, Boeing, to Joseph Hickey, Department of Ecology, RE: Underground Concrete Septic Tank – North Boeing Field, 3-800 Site. March 8, 1990. [140]

Boeing. 1990b. Letter from L.M. Babich III, Boeing, to Pam Elardo, Washington State Department of Ecology, RE: NPDES Permit No. WA-000086-8, Schedule of Compliance, Non-Contact Cooling Water Reduction Report. May 29, 1990. [196]

Boeing. 1990c. Letter from Guy Bruno, Boeing, to Elin Abramson, Washington State Department of Ecology, RE: Discovery of Past Release – North Boeing Field, Blast Fence, Apron A, Utilidor Project. August 16, 1990. [113]

Boeing. 1990d. Letter from Guy D. Bruno, Boeing, to Elin Abramson, Washington Department of Ecology, RE: Discovery of Past Release – North Boeing Field, IDP Building Construction Excavation. August 31, 1990. [108]

Boeing. 1991a. Letter from L.M. Babich III, Boeing, to Mike Rundlett, Washington State Department of Ecology, RE: Intent to Conduct Independent Action – Characterization and Remediation of Petroleum Impacted Soil at North Boeing Field, King County, Washington. August 19, 1991. [149]

Boeing. 1991b. Letter from Guy D. Bruno, Boeing, to Belinda Hovde, Washington State Department of Ecology, RE: Discovery of Past Release – North Boeing Field, Pre-Construction Environmental Investigation, Proposed 3-354 Building Site. November 15, 1991. [110]

Boeing. 1991c. Letter from Jenette Ramos, Boeing Commercial Airplane Group, to Pam Elardo, Department of Ecology, RE: Discharge of Synthetic Firefighting Foam. November 27, 1991. [222]

Boeing. 1992a. Letter from L.M. Babich III, Boeing, to Joseph Hickey, Department of Ecology, RE: Underground Storage Tank Testing Program – North Boeing Field. January 13, 1992. [137]

Boeing. 1992b. Letter from L.M. Babich III, Boeing Commercial Airplane Group, to Pam Elardo, Water Quality, Washington State Department of Ecology, RE: North Boeing Field NPDES Permit WA-000086-8, Spill Report. February 12, 1992. [230]

Boeing. 1992c. Letter from Robert Becker, Boeing, to Joseph Hickey, Washington State Department of Ecology, RE: Closure of Underground Storage Tanks. February 21, 1992. [136]

Boeing. 1992d. Letter from L.M. Babich III, Boeing, to Michael J. Gallagher, Washington State Department of Ecology, RE: Discovery of Past Release – North Boeing Field, Pre-Construction Environmental Investigation – 3-840 Fire Station. March 9, 1992. [147]

Boeing. 1992e. Letter from L.M. Babich III, Boeing, to Michael J. Gallagher, Washington State Department of Ecology, RE: Report of Independent Action – North Boeing Field Proposed Building 3-354. March 27, 1992. [112]

Boeing. 1992f. Letter from L.M. Babich III, Boeing, to Sheri Dotson, Department of Ecology, RE: Notice of Permanent Closure of Underground Storage Tanks, Green Hornet Wind Tunnel Facility, North Boeing Field. July 28, 1992. [135]

Boeing. 1992g. Letter from L.M. Babich III, Boeing, to Joseph Hickey, Washington Department of Ecology, RE: Independent Cleanup Action Report – Flight Line Utilities Project Concourse C, North Boeing Field, Seattle, Washington. August 5, 1992. [95]

Boeing. 1992h. Letter from L.M. Babich III, Boeing, to Pam Elardo, Washington State Department of Ecology, RE: NPDES Permit No. WA-00086-8, North Boeing Field Facility. September 23, 1992. [171]

Boeing. 1992i. Letter from James Medzegian, Boeing, to Ed O'Brien, Industrial Storm Water Unit, Washington Department of Ecology, RE: NOI for North Boeing Field. September 28, 1992. [172]

Boeing. 1992j. Letter from L.M. Babich III, Boeing, to Joseph Hickey, Washington Department of Ecology, RE: Tank Removals and Remediation Plans for North Boeing Field Main Fuel Farm, Seattle, Washington. November 2, 1992. [134]

Boeing. 1992k. Letter from L. Mike Babich, Boeing, to Michael Gallagher, Washington State Department of Ecology, RE: Update Release Notification – North Boeing Field Fire Training Facility. December 16, 1992. [164]

Boeing. 1993a. Letter from L.M. Babich III, Boeing Commercial Airplane Group, to Kevin Fitzpatrick, Industrial Permits, Washington State Department of Ecology, RE: Replacement Oil-Water Separator, North Boeing Field Fuel Farm. February 9, 1993. [229]

Boeing. 1993b. Letter from L.M. Babich III, Boeing Commercial Airplane Group, to Kevin Fitzpatrick, Washington State Department of Ecology, RE: March 1 discharge of hot water. March 11, 1993. [235]

Boeing. 1993c. Letter from L.M. Babich III, Boeing Commercial Airplane Group, to Kevin Fitzpatrick, Washington State Department of Ecology, RE: March 3 discharge of hot water. March 11, 1993. [236]

Boeing. 1993d. Letter from L.M. Babich III, Boeing Commercial Airplane Group, to Kevin Fitzpatrick, Industrial Permits, Washington State Department of Ecology, RE: Oil-Water Separator, North Boeing Field Concourse B. April 19, 1993. [228]

Boeing. 1993e. Letter from L.M. Babich III, Boeing, to Michael Gallagher, Toxics Cleanup Program, Ecology, RE: Reporting of an Independent Remedial Action under MTCA. April 30, 1993. [10]

Boeing. 1993f. Letter from L.M. Babich III, Boeing, to Michael Gallagher, Washington State Department of Ecology, RE: North Boeing Field, WAD 980982037. May 10, 1993. [143]

Boeing. 1993g. Letter from L.M. Babich III, Boeing, to Michael Gallagher, Washington State Department of Ecology, RE: Independent Remedial Action – North Boeing Field Fire Training Facility. August 18, 1993. [103]

Boeing. 1993h. Letter from L.M. Babich III, Boeing, to Judith M. Aitken, Washington State Department of Ecology, RE: North Boeing Field Storm Sewer Remediation Program, Landau Storm Drain Cleanout Report of April 14, 1993. September 13, 1993. [168]

Boeing. 1994a. Letter from L.M. Babich III, Boeing, to Pam Elardo, Washington State Department of Ecology, RE: Storm Water Baseline General Permit, Permit Number SO3-000226. March 9, 1994. [195]

Boeing. 1994b. Letter from L.M. Babich III, Boeing, to Pam Elardo, Washington State Department of Ecology, RE: Wastewater Permit Fee, North Boeing Field Facility. March 29, 1994. [227]

Boeing. 1994c. Letter from L.M. Babich III, Boeing, to Pam Elardo, Washington State Department of Ecology, RE: NPDES Form 2F Sampling Proposal. May 6, 1994. [184]

Boeing. 1994d. Letter from L.M. Babich III, Boeing, to Joe Hickey, Washington State Department of Ecology, RE: Document Transmittal. May 12, 1994. [144]

Boeing. 1994e. Letter from L.M. Babich III, Boeing, to Pam Elardo, Washington State Department of Ecology, RE: NPDES Permit Number WA-00086-8, Boeing Commercial Airplane Group, North Boeing Field Facility. May 18, 1994. [185]

Boeing. 1994f. Letter from L.M. Babich III, Boeing Commercial Airplane Group, to Pam Elardo, Washington State Department of Ecology, RE: Rain Erosion Facility Discharge. June 17, 1994. [225]

Boeing. 1994g. Letter from L.M. Babich III, Boeing Commercial Airplane Group, to Pam Elardo, Washington State Department of Ecology, RE: Discharge to Storm Sewer System. July 19, 1994. [224]

Boeing. 1994h. Letter from L.M. Babich III, Boeing Commercial Airplane Group, to Pam Elardo, Washington State Department of Ecology, RE: Aqueous Film Forming Foam (AFFF) Discharge July 20, 1994, North Boeing Field F&G Fuel Slabs. August 4, 1994. [223]

Boeing. 1994i. Letter from L.M. Babich III, Boeing Commercial Airplane Group, to Pam Elardo, Washington State Department of Ecology, RE: Discharge Monitoring Report for July 1, 1994 through September 30, 1994. October 6, 1994. [238]

Boeing. 1994j. Letter from L.M. Babich III, Boeing, to Pam Elardo, Washington State Department of Ecology, RE: NPDES 2F Submittal, NPDES Permit Number WA-000086-8. November 21, 1994. [183]

Boeing. 1994k. Letter from L.M. Babich III, Boeing, to Pam Elardo, Washington State Department of Ecology, RE: NPDES Permit No. WA-000086-8, North Boeing Field. December 7, 1994. [186]

Boeing. 1995a. Letter from L.M. Babich III, Boeing, to Michael Gallagher, Washington State Department of Ecology, RE: MTCA Release Report and Report of Independent Cleanup Action, North Boeing Field Boiler Fuel Tanks UBF-22 and UBF-23, Building 3-374, Seattle, Washington. January 30, 1995. [89]

Boeing. 1995b. Letter from L.M. Babich III, Boeing, to Michael Gallagher, Washington State Department of Ecology, RE: MTCA Release Report, North Boeing Field Building 3-333 Site, Seattle, Washington. January 30, 1995. [97]

Boeing. 1995c. Letter from L.M. Babich III, Boeing, to Pam Elardo, Washington State Department of Ecology, RE: NPDES 2F Submittal Follow-Up, NPDES Permit Number WA-000086-8. February 8, 1995. [187]

Boeing. 1995d. Letter from James V. Medzegian, Boeing Commercial Airplane Group, to James D. Krull, Water Quality Program, Washington State Department of Ecology, RE: NOI Renewal for Baseline General Permit Number SO3-000226. May 17, 1995. [174]

Boeing. 1995e. Letter from L.M. Babich III, Boeing, to Pam Elardo, Washington State Department of Ecology, RE: NPDES Form 2F – Non Stormwater Discharge Certification Statement, NPDES Permit Number WA-000086-8. September 28, 1995. [188]

Boeing. 1996a. Letter from L.M. Babich III, Boeing, to Ron DeVitt, Washington State Department of Ecology, RE: North Boeing Field NPDES Permit Number SO3000226. April 1, 1996. [189]

Boeing. 1996b. Letter from L.M. Babich III, Boeing, to Michael Gallagher, Washington State Department of Ecology, RE: Transmittal of Independent Soil Cleanup Action Report, Proposed 3-333 Building Location, North Boeing Field, Seattle, WA. November 26, 1996. [90]

Boeing. 1997. Letter from S.T. Karich, Boeing Commercial Airplane Group, to Ron Devitt, Washington Department of Ecology, RE: Best Management Practice (BMP) for the 3-369 WWTP. May 20, 1997. [177]

Boeing. 1998a. Letter from L.M. Babich III, Boeing, to Michael Gallagher, Washington State Department of Ecology, RE: Transmittal of Supplemental Investigation Report, and Remedial Action Report, Proposed West Wing 3-333 Building Fuel Test Laboratory, North Boeing Field, Seattle, Washington. February 24, 1998. [102]

Boeing. 1998b. Letter from L.M. Babich III, Boeing, to Michael Gallagher, Washington State Department of Ecology, RE: MTCA Release Report Transmittal, Building 3-326 Vicinity, Boeing Commercial Airplane Group, North Boeing Field. April 30, 1998. [26]

Boeing. 1998c. Letter from L.M. Babich III, Boeing, to Carla Skog, Washington State Department of Ecology, RE: Petroleum Contamination at North Boeing Field, Seattle, WA. September 14, 1998. [93]

Boeing. 1999. Letter from L.M. Babich III, Boeing, to Ron Devitt, Washington State Department of Ecology, RE: North Boeing Field NPDES Permit Number SO3000226, Stormwater Baseline General Permit for Industrial Activity, Diesel Spill Report. January 20, 1999. [180]

Boeing. 2000. Letter from L.M. Babich III, Boeing, to Linda Matlock, Washington State Department of Ecology, RE: Request for Renewal of Coverage Under the General Permit to Discharge Stormwater Associated with Industrial Activity – Permit Number SO3-000226. May 8, 2000. [181]

Boeing. 2001. Letter from Charles Keller, The Boeing Company, to Dan Duncan, PCB Coordinator, Environmental Protection Agency, Region 10, RE: Management of Concrete Joint Material Containing Polychlorinated Biphenyls (PCBs) at Boeing's North Boeing Field Facility. September 17, 2001. [200]

Boeing. 2002. Washington – Plant 2/Boeing Field. Facility Map. [101]

Boeing. 2004a. Letter from Michael L. Verhaar, Boeing, to Don Seeburger, Washington State Department of Ecology, RE: North Boeing Field NPDES Permit Number SO3000226, 3-335 Fuel Test Facility AFFF Release to Duwamish. July 6, 2004. [190]

Boeing. 2004b. Application for Renewal, King County Department of Natural Resources, Wastewater Discharge Permit. The Boeing Company, North Boeing Field Facility, Existing Permit #7594. November 2004. [170]

Boeing. 2005a. Letter from Rudolph Rogers, Boeing, to Dan Duncan, PCB Coordinator, Environmental Protection Agency, Region 10, RE: Technical Memorandum – 2004 Removal of Concrete Joint Material at North Boeing Field. February 24, 2005. [3]

Boeing. 2005b. Letter from Carl Bach, Boeing, to Dan Cargill, Ecology, RE: Lower Duwamish Waterway Source Control Information Request, Slip 4 Early Action Drainage Basin. November 16, 2005. [24]

Bridgewater Group. 2000. Preliminary Assessment for the Seattle City Light Georgetown Steam Plant. Prepared for Seattle City Light by Bridgewater Group, Inc. December 18, 2000. [78]

Bridgewater Group. 2002. Phase II Site Assessment Results for the Georgetown Steam Plant. Prepared for Seattle City Light and Striplin Environmental Associates by Bridgewater Group, Inc. March 29, 2002. [79]

Cargill. 2004. Notes from Telecon between Dan Cargill, Ecology, and Jennie Goldberg, SCL, RE: Bank samples and flume monitoring. September 16, 2004. [29]

Cargill. 2005a. Notes on telephone conversations between Dan Cargill, Ecology, and Dan Duncan, USEPA (September 8, 2005) and Carl Bach, Boeing (September 9, 2005), RE: concrete joint caulk. [7]

Cargill. 2005b. Email from Dan Cargill, Ecology, to Source Control Work Group RE: North Boeing Field Source Control Investigation. December 6, 2005. [15]

Cargill. 2006. Email from Dan Cargill, Ecology, to Carl Bach, Boeing, RE: June 2006 SW Vault Sediment Sampling Data. August 25, 2006. [127]

CDM (Camp Dresser & McKee Inc.). 2000. Site Investigation, Building 3-304 Demolition, North Boeing Field, Seattle, Washington. Prepared for The Boeing Company. December 27, 2000. [122]

CDM. 2001. Soil Assessment, Building 3-304, North Boeing Field, Seattle, Washington. Prepared for The Boeing Company. December 14, 2001. [123]

DNR (Washington State Department of Natural Resources). 1989. Letter from David W. Jamison, Division of Aquatic Lands, DNR, to Pam Elardo, Department of Ecology, RE: Sediment Impacts to Aquatic Lands, Permit No. WA-000086-8, North Boeing Field. August 23, 1989. [199]

Ecology (Washington State Department of Ecology). 1976. Letter from Robert K. McCormick, Ecology, to Pete Henault, City of Seattle Department of Lighting, RE: Issuance of Revised NPDES Permit, Georgetown Facility, Permit No. WA-000328-0. May 17, 1976. [242]

Ecology. 1984. Letter from B. Smith, Ecology, to S. Messman, J. Conroy, G. Brugger, M. Dawda, RE: Boeing – North Field / Seattle City Light-Georgetown, Soil and Sediment Sampling. June 19, 1984. [36]

Ecology. 1985a. Memorandum from Mike Schlender, Ecology, to Merly McCall and Gary Brugger, Ecology, RE: Analysis of Duwamish Slip #4 Oil Samples. February 26, 1985. [45]

Ecology. 1985b. Letter from Gary L. Brugger, Ecology, to Timothy Croll, SCL, RE: Georgetown PCB Cleanup. [50]

Ecology. 1985c. Memorandum from Mike Schlender, Ecology, to Gary Brugger, Ecology, RE: PCB Analysis of Duwamish Slip Number 4 Sediment Samples. April 16, 1985. [246]

Ecology. 1986a. Letter from Dan Cargill, Department of Ecology, to David Smukowski, The Boeing Company, RE: Your ltr G-1780-MJM-334 of July 16, 1986. July 29, 1986. [208]

Ecology. 1986b. Letter from Marie Zuroske, Ecology, to Walter Becker, Eastern Electric Apparatus Repair Company, Inc., RE: Transformer Handling. December 8, 1986. [58]

Ecology. 1987a. Memorandum from Craig S. Baker, Ecology, to Norm Peck, Ecology, RE: Oil Spill, Boeing Field, Galvin Flying Service. March 5, 1987. [212]

Ecology. 1987b. Letter from Ali Raad, Department of Ecology, to Edward Cifra, Boeing Commercial Airplane Co., RE: Failure to Submit Engineering Report for the Industrial Wastewater Treatment Plant, Building 3-369, North Boeing Field. July 28, 1987. [214]

Ecology. 1987c. Spill Report, Boeing N. Field. December 17, 1987. [215]

Ecology. 1988. Telephone Record between Richard A. Koch, Ecology, and Bill Rogers, Earth Consultant. September 14, 1988. [217]

Ecology. 1989a. Department of Ecology, Northwest Regional Office, Permit Renewal Inspection Report. North Boeing Field. March 10, 1989. [231]

Ecology. 1989b. Letter from Pam Elardo, Washington Department of Ecology, to Clyde R. Cherberg, Boeing Commercial Airplane Company, RE: Renewal of NPDES Permit No. WA-000086-8. March 17, 1989. [202]

Ecology. 1989c. Letter from Pam Elardo, Washington Department of Ecology, to L.M. Babich, Boeing Commercial Airplanes, RE: Final NPDES Permit Number WA-000086-8. September 15, 1989. [197]

Ecology. 1989d. Letter from John H. Glynn, Permits & General Water Quality, Department of Ecology, to L.M. Babich, Boeing Commercial Airplanes, RE: NPDES Permit Issuance, Permit No. WA-000086-8, North Boeing Field. December 8, 1989. [191]

Ecology. 1990a. Telephone Record between Pam Elardo, Departmetn of Ecology, and Janette Ramos, Boeing, RE: Overflow from lift station. January 3, 1990. [219]

Ecology. 1990b. Letter from Pamela Elardo, Department of Ecology, to Clyde R. Cherberg, Boeing Commercial Airplanes, RE: Discharge of propylene glycol de-icing fluid to storm sewer system. January 29, 1990. [220]

Ecology. 1990c. Letter from Pamela Elardo, Department of Ecology, to Clyde R. Cherberg, Boeing Commercial Airplanes, RE: Discharge of Deicing Fluid. February 15, 1990. [221]

Ecology. 1991a. ERT System – Initial Report / Followup, North Boeing Field Concourse C. Department of Ecology. September 4, 1991. [139]

Ecology. 1991b. ERT System – Initial Report / Followup, North Boeing Field. Department of Ecology. December 13, 1991. [138]

Ecology. 1992a. Department of Ecology ERT System – Initial Report / Followup. North Boeing Field. April 16, 1992. [237]

Ecology. 1992b. Washington Ranking Method, Route Score Summary and Ranking Calculation Sheet, Boeing North Field. August 1, 1992. [161]

Ecology. 1992c. ERT System – Initial Report / Followup, North Boeing Field. Department of Ecology. September 18, 1992. [150]

Ecology. 1992d. Letter from James D. Krull, Water Quality Program, Department of Ecology, to Joyce Nelson, Boeing Commercial Airplane Group, RE: Coverage Under the Storm Water Baseline General Permit, No. SO3-000226, North Boeing Field. December 28, 1992. [173]

Ecology. 1992e. Letter from Louise Bardy, Ecology, to L. Mike Babich, Boeing Commercial Airplane Group, RE: Independent Cleanup Action Report, North Boeing Field Fire Training Center. December 30, 1992. [165]

Ecology. 1993. Letter from Barbara J. Ritchie, Ecology, to Ann Dold, King County SEPA Center, RE: Comment on Determination of Nonsignificance for Boeing Fire Training Facility Closure. May 18, 1993. [163]

Ecology. 1994a. Letter from Pam Elardo, Water Quality Program, Department of Ecology, to L.M. Babich III, Boeing Commercial Airplane Group, RE: Request for Permit Modification, North Boeing Field. May 12, 1994. [194]

Ecology. 1994b. Letter from Pam Elardo, Water Quality Program, Department of Ecology, to L.M. Babich III, Boeing Commercial Airplane Group, RE: Temperature Limitations for North Boeing Field, Outfall 001. June 2, 1994. [226]

Ecology. 1994c. Letter from Michael Gallagher, Ecology, to Mike Babich, Boeing Commerical Airplane Group, RE: Re-ranking of North Boeing Field. August 4, 1994. [151]

Ecology. 1995. Department of Ecology Permit Compliance Inspection Report, North Boeing Field. January 24, 1995. [232]

Ecology. 1996a. Letter from James D. Krull, Water Quality Program, Department of Ecology, to Boeing Commercial Airplane Group, RE: Stormwater Baseline General Permit for Industrial Activity, SO3000226, North Boeing Field. January 10, 1996. [175]

Ecology. 1996b. Industrial Stormwater Unit Telephone Record: Darci Turner, Boeing, RE: Spill. February 6, 1996. [176]

Ecology. 1997. Letter from Ron Devitt, Water Quality, Department of Ecology, to S.T. Karich, Boeing Commercial Airplane Group, RE: Proposed BMP for the 3-369 WWTP, SO3-000226. May 29, 1997. [178]

Ecology. 1998a. Environmental Reports Tracking System, Spills Program Input Form, North Boeing Field, Building 3-313, Waste Oil Spill. January 29, 1998. [179]

Ecology. 1998b. Environmental Report Tracking System Incident History, Galvin Flying Service. December 14, 1998. [152]

Ecology. 2000. North Boeing Field – NWRO, SO3-000226, Industrial Stormwater General Permit, Coverage Date: November 18, 2000, Expiration Date: November 18, 2005. November 18, 2000. [182]

Ecology. 2005. Memorandum from Dan Cargill, Toxics Cleanup Program, NWRO, to Jim Pendowski, Toxics Cleanup Program, Washington Department of Ecology,. RE: PCBs in expansion joint compounds at airfields. April 29, 2005. [5]

Ecology. 2006. Lower Duwamish Waterway Source Control Action Plan for the Slip 4 Early Action Area. Publication No. 06-09-046. Washington State Department of Ecology. July 2006. [262]

Galvin Flying Service. 1987. Letter from Deric N. Young, Galvin Fying Service, Inc., to Craig S. Baker, Department of Ecology, RE: Boeing Field Fuel Storage Fuel Spill on 2/25/87. February 27, 1987. [211]

Goldberg. 2006. Email from Jennie Goldberg, SCL, to Dan Cargill, Ecology, RE: Prelminary assessment – copy of Ecology letter, History of Willow Substation. March 30, 2006. [66]

GTI (Groundwater Technology, Inc.). 1990a. Report, Field and Laboratory Services, Utilidor Project, North Boeing Field, Boeing Commercial Airplanes, Renton Division, Seattle, Washington. August 10, 1990. [114]

GTI. 1990b. Report, Soil Sampling and Analyses, Inlet Development Facility, North Boeing Field, Boeing Commercial Airplanes, Renton Division, Seattle, Washington. November 1990. [109]

GTI. 1991a. Report, Building 3-354 Preconstruction Environmental Assessment, North Boeing Field, Seattle, Washington. Prepared for Boeing Commercial Airplane Group. November 11, 1991. [111]

GTI. 1991b. Report, Preconstruction Environmental Assessment, Building 3-840 Expansion, North Boeing Field, Seattle, Washington. Prepared for Boeing Commercial Airplane Group. December 19, 1991. [146]

Integral (Integral Consulting, Inc.). 2006a. Lower Duwamish Waterway, Slip 4 Early Action Area. Appendix B: Summary of City of Seattle and King County Source Control Activities in the Slip 4 Drainage Basin. February 20, 1006. [65]

Integral. 2006b. Georgetown Steam Plant January 2006 Soil Sampling. Prepared for Seattle City Light by Integral Consulting, Inc. June 8, 2006. [261]

Integral. 2006c. Interim Remedial Action Completion Report, GTSP Interim Action. Prepared for Seattle City Light by Integral Consulting, Inc. August 4, 2006. [260]

ITC (IT Corporation). 2000. Independent Cleanup Report, American Avionics Property. Prepared by IT Corporation for King County International Airport. July 6, 2000. [255]

Keller. 2006a. Email from Charlie Keller, Boeing, to Dan Cargill, Ecology, RE: NBF sweep sampling. March 13, 2006. [62]

Keller. 2006b. Email from Charlie Keller, Boeing, to Dan Cargill, Ecology, RE: Sweeping at the NBF flight line. March 15, 2006. [63]

King County. 1991a. Letter from Joshua Goldfinger, King County Environmental Division, to Paul Crane, Boeing Commercial Airplane Group, RE: Pre-application Review of Bldg. 3-801 (Flight Test Engineering Lab), SEPA No. T-91-00085. September 11, 1991. [85]

King County. 1991b. Letter from Joshua Goldfinger, King County Environmental Division, to Paul Crane, Boeing Commercial Airplane Group, RE: Pre-application Review of Bldg. 3-801 (Flight Test Engineering Lab), SEPA No. T-91-00085. November 14, 1991. [86]

King County. 1993. Determination of Nonsignificance for Boeing Fire Training Facility Closure, North Boeing Field. King County Environmental Division, SEPA Section. May 4, 1993. [162]

King County. 1996. Letter from Cynthia H. Wellner, King County Water Pollution Control Division, Industrial Waste Program, to L.M. Babich III, Boeing Commercial Airplane Group, RE: Notice of Violation for pH at North Boeing Field. August 22, 1996. [160]

King County. 2005a. King County Industrial Waste Field Inspection Report, North Boeing Field. March 2, 2005. [253]

King County. 2005b. King County Industrial Waste Company Fact Sheet, Boeing Commercial Airplane – North Field. March 25, 2005. [254]

King County. 2005c. Letter from Barbara Badger, King County Wastewater Treatment Division, to Mark Jenkins, Boeing, RE: Draft of Permit No. 7594-03. March 25, 2005. [259]

King County International Airport (KCIA). 2001. Revised Draft Master Plan, King County International Airport/Boeing Field. August 2001. [11]

Landau Associates, Inc. (Landau). 1993a. Technical Memorandum from Julie Wilson, Landau Associates, Inc., to Dan Balbach, Perkins Coie, RE: North Boeing Field Storm Drain System PCB Sampling. April 6, 1993. [9]

Landau. 1993b. Data Report: Storm Drain System Cleanout, North Boeing Field, Seattle and Tukwila, Washington. April 14, 1993. [167]

Landau. 1993c. Report of Permanent Closure, Former Underground Storage Tank Near Fire Training Center, North Boeing Field, King County, Washington. Landau Associates, Inc. August 5, 1993. [104]

Landau. 2001a. Report: Concrete Expansion Joint Material Field Mapping, North Boeing Field, Seattle, Washington. Prepared for The Boeing Company. March 21, 2001. [243]

Landau. 2001b. Report: Sampling and Analysis, Concrete Joint Material, North Boeing Field, Seattle, Washington. Prepared for The Boeing Company. March 22, 2001. [245]

Landau. 2001c. Draft Report: April 2001 Sampling Investigation, Concrete Expansion Joint Material, North Boeing Field, Seattle, Washington. Prepared for The Boeing Company. May 21, 2001. [252]

Landau. 2004. Technical Memorandum from Joe Kalmar and Kris Hendrickson, Landau Associates, Inc., to Carl Bach, The Boeing Company, RE: Stormwater Filtration and Initial Testing Results, PCB Source Investigation, North Boeing Field. September 17, 2004. [25]

Landau. 2006. Technical Memorandum: 2005 Removal of Concrete Joint Material, North Boeing Field, Seattle, Washington. March 30, 2006. [70]

Municipality of Metropolitan Seattle (METRO). 1983. Memorandum from Denise Healy, METRO, to Jeff Bauman, Bob Swartz, and Gary Brugger (Ecology), RE: Inspection of Georgetown Steam Plant. September 28, 1983. [31]

METRO. 1984a. Letter from Thomas P. Hubbard, METRO, to Chris Benson, Seattle City Light, RE: Proposed Storm Drain Monitoring. March 5, 1984. [32]

METRO. 1984b. Letter from Douglas A. Hilderbrand, METRO, to Kirk Thompson, The Boeing Company, RE: PCB Discharge to Flume. September 27, 1984. [38]

METRO. 1985a. Analytical Data from November 1984 Georgetown Flume Samples. February 1985. [250]

METRO. 1985b. Letter from John B. Lampe, METRO Water Quality Division, to W.R. Diefenderfer, Facilities Plant Engineering, Boeing Commercial Airplane Company, RE: Metro Permit No. 7180 for North Boeing Field. October 7, 1985. [68]

METRO. 1985c. Letter from Vallana M. Piccolo, Industrial Waste Investigator, METRO, to W.R. Diefenderfer, Boeing Commercial Airplane Company, RE: Building 3-404 Oil Separator at North Boeing Field. November 14, 1984. [67]

METRO. 1990a. METRO Permit Fact Sheet. Permit No. 7594, Boeing Commercial Airplanes – North Boeing Field. May 11, 1990. [155]

METRO. 1990b. Letter from Elsie J. Hulsizer, METRO, to L.M. Babich III, Boeing Commercial Airplanes, RE: Issuance of Wastewater Discharge Permit to Boeing Commercial Airplanes – North Boeing Field by the Municipality of Metropolitan Seattle (Metro), Permit No. 7594. May 11, 1990. [156]

METRO. 1993. Letter from Cynthia Wellner, METRO, to L.M. Babich III, Boeing Commercial Airplane Group, RE: Authorization to Discharge to the Sanitary Sewer. July 13, 1993. [157]

METRO. 1994. Letter from Cynthia Wellner, METRO, to Doug Knutson, Department of Ecology, RE: Permit Renewal Application for North Boeing Field. November 15, 1994. [169]

METRO. 1995a. King County Department of Metropolitan Services Permit Fact Sheet, Permit No. 7594, Boeing North Field. April 26, 1995. [158]

METRO. 1995b. Letter from Christie J. True, Industrial Waste Section, METRO, to L.M. Babich III, Boeing Commercial Airplane Group, RE: Issuance of Wastewater Discharge Permit No. 7594 to Boeing Commercial Airplane Group by the King County Department of Metropolitan Services (Metro). May 10, 1995. [159]

Puget Sound Clean Air Agency (PSCAA). 2002. Air Operating Permit No. 21147. Issued to: Boeing Commercial Airplane Group – North Boeing Field / Plant 2. Expires May 20, 2007. May 20, 2002. [4]

Raven Systems and Research, Inc. (Raven). 1984a. Maps titled "Georgetown Flume PCBs Problem." April 3, 1984. [33]

Raven. 1984b. Seattle City Light Work Order 84-4, Soil Sampling to Test for PCB Contamination, Georgetown Steam Plant/Bothell Substation. November 1984. [39]

Raven. 1984c. Work Authorization #84-6, Sampling at Georgetown Steam Plant, Phase III. November 1984. [40]

Raven. 1984d. Final Report, Seattle City Light Work Order 84-9, Sampling to Test for PCB Contamination at the Georgetown Steam Plant Flume, Phase IV. November 1984. [43]

Raven. 1985. Seattle City Light Work Order 85-6, Georgetown Steam Plant Area PCB Sampling. May 20, 1985. [48]

Raven. 1988. Seattle City Light Work Order #87-10, Analysis of Historic Sampling Results from Georgetown Steam Plant and Environs. January 14, 1988. [251]

Renaud. 2005. Email from Rick Renaud, KCIA, to Kris Flint, USEPA, RE: Results of sampling at Lot 12, KCIA. November 3, 2005. [6]

Renaud. 2006. Email from Rick Renaud, KCIA, to Dan Cargill, Ecology, RE: KCIA – 06/06/06 to 06/09/06 Sampling – PCB Results. June 16, 2006. [119]

Schmoyer. 2005a. Email from Beth Schmoyer, SPU, to Carl Bach, Boeing, RE: Proposed Sediment Trap Locations. January 31, 2005. [30]

Schmoyer. 2005b. Email from Beth Schmoyer, SPU, to Source Control Working Group, RE: Slip 4 sed trap data – mislabeled station. September 16, 2005. [23]

Schmoyer. 2006. Email from Beth Schmoyer, SPU, to Dan Cargill (Ecology) and Jennie Goldberg (SCL), RE: North Boeing Field map. May 12, 2006. [76]

SCL (Seattle City Light). 1984a. Letter from Timothy Croll, SCL, to Mike Dawda, Department of Ecology, RE: Spill of Lube Oil at Georgetown Steamplant. June 12, 1984. [244]

SCL. 1984b. Letter from Timothy C. Croll, SCL, to Margo Partridge, Environmental Protection Agency, RE: Sampling Plan, Low-Lying Area. July 24, 1984. [37]

SCL. 1984c. Letter from Timothy C. Croll, SCL, to Margo Partridge, U.S. Environmental Protection Agency, RE: Proposal for Interim Remedial Action. October 26, 1984. [60]

SCL. 1984d. Maps showing PCB testing results. Seattle City Light. October 1984. [233]

SCL. 1984e. Georgetown PCB Meeting. November 8, 1984. [41]

SCL. 1984f. Letter from Timothy C. Croll, SCL, to Margo Partridge, Environmental Protection Agency, RE: Phase IV Sampling Plan, Work Authorization #84-9, PCB Testing at the Georgetown Steam Plant Flume. November 13, 1984. [42]

SCL. 1985a. Letter from Timothy C. Croll, SCL, to Gary Brugger, Washington Department of Ecology, RE: Sampling Plan for Low-Lying Area. February 21, 1985. [44]

SCL. 1985b. Map Showing Detention Basin Plastic Cover. February 26, 1985. [46]

SCL. 1985c. Letter from Timothy C. Croll, SCL, to Gary Brugger, Ecology, RE: Seattle City Light Draft GTSP and Flume Cleanup Plan. April 25, 1985. [47]

SCL. 1985d. Letter from Timothy C. Croll, SCL, to Gary Brugger, Ecology, RE: Oil Spill Cleanup. July 31, 1985. [49]

SCL. 1985e. Letter from Timothy C. Croll, SCL, to Gary Brugger, Ecology, RE: Georgetown PCB Cleanup. August 22, 1985. [51]

SCL. 1985f. Letter from Gary L. Farr, SCL, to Chris Loutsis, King County, RE: Seattle City Light's Georgetown Steamplant Flume. September 25, 1985. [52]

SCL. 1985g. Letter from Timothy C. Croll, SCL, to Kirk Thomson, The Boeing Company, RE: Cleanup of Georgetown Steam Plant site, flume and designated portion of Boeing storm water system. November 25, 1985. [148]

SCL. 1986. Letter from Timothy C. Croll, SCL, to Gary Brugger, Ecology, RE: Georgetown PCB Cleanup. January 27, 1986. [53]

SCL. 1988a. Letter from Shirli Axelrod, SCL, to Barbara J. Ritchie, Washington Department of Ecology, RE: DNS on Georgetown Steam Plant Tank Removal. February 18, 1988. [247]

SCL. 1988b. Letter from Shirli Axelrod, SCL, to Lawrence Ashley, Washington Department of Ecology, RE: Cleaning and removal of underground storage tanks at Georgetown Steam Plant. February 19, 1988. [248]

SCL. 1992. Letter from Mingta Lin, SCL, to Tom Cusack, Department of Ecology, RE: Transformer Rinsate. May 27, 1992. [249]

SCL. 2006. Letter from Wanda B. Schulze, SCL, to Daniel L. Duncan, Regional PCB Program Manager, EPA Region 10, RE: PCB contamination at Georgetown Steam Plant property. May 4, 2006. [75]

SEA (Striplin Environmental Associates). 2004. Lower Duwamish Waterway Slip 4 Early Action Area, Summary of Existing Information and Identification of Data Gaps. Final. Prepared for U.S. Environmental Protection Agency, Region 10. January 15, 2004. [77]

SEACOR. 1991a. Pre-Construction Environmental Investigation, Proposed 3-801 Building Site, North Boeing Field, King County, Washington. Prepared for The Boeing Company. August 12, 1991. [105]

SEACOR. 1991b. Supplemental Pre-Construction Environmental Investigation, Proposed 3-801 Building Site, North Boeing Field, King County, Washington. Prepared for The Boeing Company. October 3, 1991. [106]

SEACOR. 1992a. Pre-Construction Environmental Investigation, Proposed 7-027-1/2/3 and 3-360/361/365 Building Sites, North Boeing Field, King County, Washington. Prepared for The Boeing Company. February 14, 1992. [91]

SEACOR. 1992b. Independent Cleanup Action Report, Flight Line Utilities Project, Concourse C, North Boeing Field, Seattle, Washington. Prepared for The Boeing Company. July 14, 1992. [96]

SEACOR. 1992c. Site Assessment, Main Fuel Farm, North Boeing Field, Seattle, Washington. Prepared for The Boeing Company. September 1, 1992. [94]

SEACOR. 1992d. Operations Summary Report – Floating Non-Aqueous Phase Liquid Recovery System, Main Fuel Farm, North Boeing Field, Seattle, Washington. Prepared for The Boeing Company. October 27, 1992. [133]

SEACOR. 1992e. Independent Soil Remediation Action Report, Flight Test Engineering Laboratory, 3-801 Building Location, North Boeing Field, Seattle, Washington. Prepared for The Boeing Company. December 14, 1992. [107]

SEACOR. 1992f. Site Assessment Investigation, 3-800 Building, North Boeing Field, Seattle, Washington. Prepared for The Boeing Company. December 14, 1992. [118]

SEACOR. 1993. Supplemental Site Investigation, Building Group 7-027-1/2/3, North Boeing Field, Seattle, Washington. Prepared for The Boeing Company. March 16, 1993. [154]

SEACOR. 1994a. Preclosure Site Assessment Investigation, F&G Facility, North Boeing Field, Seattle, Washington. Prepared for The Boeing Company. April 13, 1994. [145]

SEACOR. 1994b. Supplemental Site Assessment Investigation, Green Hornet Area, North Boeing Field, Seattle, Washington. Prepared for The Boeing Company. April 14, 1994. [99]

SECOR. 1994c. Report for UST Decommissioning Site Assessment and Monitoring Well Abandonment, F&G Facility, North Boeing Field, Seattle, Washington. Prepared for The Boeing Company. October 25, 1994. [153]

SECOR. 1994d. Site Assessment and Independent Soil Cleanup Action During the Decommissioning of an Oil/Water Separator, Main Fuel Farm, North Boeing Field, Seattle, Washington. Prepared for The Boeing Company. November 7, 1994. [117]

SECOR. 1994e. Site Assessment During the Decommissioning of Underground Storage Tanks BF-22 and BF-23, 3-375 Building, Boeing Commercial Airplane Group, North Boeing Field, Seattle, Washington. Submitted by SECOR for The Boeing Company. November 22, 1994. [92]

SECOR. 1996a. Work Plan, Independent Soil Cleanup Action, Proposed 3-333 Building Location, North Boeing Field, Seattle, Washington. Prepared for The Boeing Company. February 22, 1996. [84]

SECOR. 1996b. Independent Soil Cleanup Action Report, Proposed 3-333 Building Location, North Boeing Field, Seattle, Washington. Prepared for The Boeing Company. July 2, 1996. [83]

SPU (Seattle Public Utilities) and King County. 2004. Industrial Waste (KCIW) and Seattle Public Utilities (SPU). 2004. June 2004 Progress Report. Prepared by Seattle Public Utilities and King County Industrial Waste. [80]

SPU and King County. 2005a. King County and Seattle Public Utilities Source Control Program for the Lower Duwamish Waterway, January 2005 Progress Report. Prepared for U.S. Environmental Protection Agency, Region 10, and Washington State Department of Ecology, by Seattle Public Utilities and King County Industrial Waste. [81]

SPU and King County. 2005b. King County and Seattle Public Utilities Source Control Program for the Lower Duwamish Waterway, June 2005 Progress Report. Prepared for U.S. Environmental Protection Agency, Region 10, and Washington State Department of Ecology, by Seattle Public Utilities and King County Industrial Waste. [82]

Tiffany. 2006a. Email from Bruce Tiffany, KCIA, to Dan Cargill, Ecology, RE: Data from recent stormwater sampling event. August 25, 2006. [126]

Tiffany. 2006b. Email from Bruce Tiffany, KCIA, to Dan Cargill, Ecology, RE: Biosolids truck washing operation. August 25, 2006. [129]

USEPA (U.S. Environmental Protection Agency). 1976. Letter from Lyman J. Nielsen, USEPA, to Robert McCormick, Department of Ecology, RE: Modification of NPDES permits for steam electric power plants. [241]

USEPA. 1984. Potential Hazardous Waste Site Identification, Boeing North Field. August 10, 1984. [166]

WPCC (Water Pollution Control Commission). 1970. Memorandum from Stew Messman, WPCC, RE: Boeing Field Inspection. April 29, 1970. [239]

Table 1
North Boeing Field Building List

Building No.	Building Name	Type
3-100	Stall A-1	Crew Shelter
3-101	Stall A-2	Crew Shelter
3-102	Stall A-3	Crew Shelter
3-103	Stall A-4	Crew Shelter
3-104	Stall A-5	Crew Shelter
3-105	Stall A-6	Crew Shelter
3-106	Stall B-1	Crew Shelter
3-107	Stall B-2	Crew Shelter
3-108	Stall B-3	Crew Shelter
3-109	Stall B-4	Crew Shelter
3-110	PSM	Trailer
3-111	Stall C-4	Crew Shelter
3-112	Stall B-5	Crew Shelter
3-113	Stall B-6	Crew Shelter
3-114	Stall B-7	Crew Shelter
3-115	Stall B-8	Crew Shelter
3-116	Stall B-9	Crew Shelter
3-117	Stall B-10	Crew Shelter
3-118	Stall B-11	Crew Shelter
3-119	Stall B-12	Crew Shelter
3-120	Stall C-7	Crew Shelter
3-121	Stall C-3	Crew Shelter
3-122	Stall C-6	Crew Shelter
3-123	Stall C-5	Crew Shelter
3-124	Stall C-13	Crew Shelter
3-125	Stall C-6	Crew Shelter
3-126	Stall A-6	Crew Shelter
3-127	Stall B-1.5	Crew Shelter
3-128	Stall B-2.5	Crew Shelter
3-129	Stall B-3.5	Crew Shelter
3-130	Stall B-4.5	Crew Shelter
3-132	Stall B-13	Crew Shelter
3-133	Stall C-14	Crew Shelter
3-134	Stall C-8	Crew Shelter
3-135	Stall C-9	Crew Shelter
3-136	Stall C-10	Crew Shelter
3-137	Stall C-11	Crew Shelter
3-138	Stall C-12	Crew Shelter
3-296	Gate C-4	Gatehouse
3-302	Roots Vacuum Pump and Storage	Factory
3-306	Restrooms	Support
3-310	Fuel Control Room	Factory
3-313	Regulated Waste Storage	Storage
3-314	400 MHz transformer	Factory
3-315	Nozzle Test Facility	Factory
3-317	Storage Shed	Storage
3-322	Hazardous Test Lab	Lab

Table 1
North Boeing Field Building List

Building No.	Building Name	Type
3-323	Rapid Prototyping Lab	Lab
3-324	Engineering	Office
3-326	Pneumatic & Calibration Lab	Lab
3-329	Storage Shed	Storage
3-331	Pump house	Factory
3-332	PEL Pump House	Trailer
3-333	Fuel Test Facility	Lab
3-334	Air Compressor Facillity	Factory
3-335	Fuel Test Facility	Factory
3-342	Portable HazMat Storage	Storage
3-343	Portable HazMat Storage	Storage
3-350	Hangar -Chase Plane	Hangar
3-351	Jack Test Facility	Factory
3-352	Weld Shop	Factory
3-353	Parts storage	Factory
3-354	Facilities Hydraulics	Factory
3-355	Steam Clean Building	Factory
3-356	Barrel Storage	Storage
3-357	Hydraulic Shop Storage Shed	Storage
3-364	Gate C-50	Gatehouse
3-365	Carpenter/paint shop	Factory
3-367	Waste Storage Building	Storage
3-368	Wind Tunnel Control House	Factory
3-369	Paint Hangar	Factory
3-370	Composit Repair	Factory
3-374	Boiler House	Factory
3-379	400 Hz Power Bldg	Factory
3-380	Paint Hangar	Factory
3-390	Flight Test Hangar	Factory
3-397	Pump house/Tanks	Factory
3-447	Dispatch	Trailer
3-626	Test Support Bldg	Support
3-798	Flt Test Radio Services	Factory
3-799	NA	Trailer
3-800	Customer Delivery Center and Flight Test Engineering	Office
3-801	Flight Delivery Center	Office
3-818	Quick Change Building/Wire Shop	Factory
3-822	Fuel Control Bldg	Factory
3-825	NA	Office
3-826	Flight Lane 400Hz Bldg	Factory
3-833	Gate C-16	Gatehouse
3-834	Crew Support Building C-5	Crew Shelter
3-836	Gate C-39	Gatehouse
3-840	Fire Station	Factory
3-841	Wash Stall Support	Support
7-27.1	Markov Building	Warehouse

Table 2
Soil Sampling Results -- UBF-55 (mg/kg)

Sample Location	Depth Interval	Aroclor 1248	Aroclor 1254	Aroclor 1262	Total PCBs
P1	Lower	0.22	0.063	0.042 U	0.28
P2	Lower	27	9.4	0.89 U	36
P3	Lower	14	3.7	0.037 U	18
P4	Lower	37	9.3	0.9 U	46
P5	Lower	0.036 U	0.022 J	0.015 J	0.073
P6	Upper	0.036 U	0.036 J	0.048	0.12
P6	Lower	0.037 U	0.037 U	0.018 J	0.092
P7	Upper	0.85 U	260	0.85 U	261
P7	Lower	88 U	570	0.88 U	658
P8	Lower	4	1.4	0.038 U	5.4
P8-DUP	Lower	3.9	1.5	0.038 U	5.4
P9	Lower	82	14	0.86 U	96
P10	Lower	0.037 U	0.037 U	0.017 J	0.091
P11	Lower	0.037 U	0.042	0.028 J	0.11
P13B	Lower	0.5	0.16	0.036 U	0.66
P14	Lower	0.037 U	0.095	0.037 U	0.13
P15	Lower	3.4	2.4	0.037 U	5.8
P15-DUP	Lower	4.2	2.9	0.037 U	7.1
P16	Upper	100	72	0.88 U	172
P16	Lower	1,000	540	0.92 U	1,540
P17	Upper	0.51	0.41	0.042 U	0.92
P17	Lower	0.12	0.038 U	0.038 U	0.16
P18	Lower	0.052	0.038 U	0.038 U	0.090
P19	Lower	0.12	0.052	0.038 U	0.17

Notes:

Only detected Aroclors are shown.
Sample locations are shown on Figure X.

	Indicates samples with total PCBs > 10 mg/kg
	Indicates samples with total PCBs > 100 mg/kg

Source: AGI 1998 [88]

Table 3
Summary of PCB Sediment Trap Data, North Boeing Field (mg/kg)
(through Round 2)

Location	Date Sampled	Total PCBs (mg/kg)
SL4-T1 (MH-422)	8/11/2005	10
	3/16/2006	107
SL4-T2A (MH-482)	8/11/2005	0.18
	3/16/2006	0.38
SL4-T2 (MH-356)	8/11/2005	0.84
	3/16/2006	1.5
SL4-T3A (MH-19C)	8/11/2005	0.038
	3/16/2006	0.73
SL4-T3 (MH-364)	8/11/2005	1.4
	3/16/2006	1.8
SL4-T4A (MH-229A)	8/11/2005	0.45
	3/16/2006	0.11
SL4-T4 (MH-221A)	8/11/2005	2.8 P
	3/16/2006	1.1
SL4-T5A (MH-178)	8/11/2005	0.11
	3/16/2006	0.65
SL4-T5 (MH-363)	8/11/2005	24
	3/16/2006	114

Table 4
Summary of NBF Catch Basin PCB Sampling

Location	Date Sampled	Total PCBs (mg/kg)	Date of Most Recent Cleanout
CB113	7/7/2000	31.7	8/24/2006
CB113	9/26/2005	28	
CB113	7/25/2006	15 U	
CB114	7/15/1992	1.62	10/14/2005
CB114	8/11/1998	0.53	
CB114	5/1/2000	0.52	
CB114	9/26/2005	0.87	
CB173	7/17/1992	12.8	8/22/2006
CB173	9/22/1997	33	
CB173	8/7/1998	49.4	
CB173	9/26/2005	1310	
CB173	10/24/2005	247	
CB173	10/24/2005	400	
CB173	3/21/2006	110	
CB173	4/26/2006	29	
CB173	5/30/2006	122	
CB173	6/22/2006	26	
CB174	10/24/2005	13.7	8/22/2006
CB174A	10/24/2005	7.2	11/15/2005
CB175	10/24/2005	2.88	11/15/2005
CB175	4/26/2006	3.2	
CB182	7/16/1992	19	11/15/2005
CB182	10/18/1996	18	
CB182	8/7/1998	3.4	
CB182	3/21/2006	14	
CB182	4/26/2006	6.1	
CB185	7/16/1992	220	11/15/2005
CB185	8/7/1998	7.9	
CB185	3/21/2006	5.5	
CB185	4/26/2006	11	
CB185	7/25/2006	2	
CB193	6/29/2000	12.27	8/21/2006
CB193	10/27/2005	16.5	
CB193	7/25/2006	12	
CB194	10/24/2005	14.1	8/21/2006
CB194	7/25/2006	20.3	
CB209B	5/4/2000	0.18	NA
CB209B	9/26/2005	0.07	
CB224	8/18/1998	145	11/29/2005
CB224	5/1/2000	49	
CB224	5/13/2005	43	
CB224	7/25/2006	5.6	
CB225	8/18/1998	82	10/5/2005
CB225	7/7/2000	13	
CB225	7/25/2006	27.9	
CB227	7/25/2006	7.5	10/13/2005

Table 4
Summary of NBF Catch Basin PCB Sampling

Location	Date Sampled	Total PCBs (mg/kg)		Date of Most Recent Cleanout
CB228F	6/20/2000	161		10/7/2005
CB228F	5/13/2005	22		
CB228F	7/26/2006	3.5	U	
CB364A	8/14/2000	70		8/24/2006
CB364A	5/13/2005	11		
CB364A	7/26/2006	5.5		
CB370	8/13/1998	158		NA
CB370	6/3/2000	40		
CB370	7/26/2006	28		
CB372	6/20/2000	45		10/13/2005
CB372	7/26/2006	32.8		
CB372A	6/20/2000	51		10/18/2005
CB372A	5/13/2005	8.8		
CB384	8/14/2000	130		10/21/2005
CB384	5/13/2005	16		
CB416	7/19/2000	42		10/5/2005
CB416	5/13/2005	50		
CB416	6/6/2005	16		
CB416	7/26/2006	14.6		
CB418	7/19/2000	23		10/5/2005
CB418	6/6/2005	4		
CB419	7/19/2000	17		10/5/2005
CB419	6/6/2005	22		
CB419	7/26/2006	6.2		
CB420	5/13/2005	30		10/19/2005
CB420	7/26/2006	8.4		
CB583	7/26/2006	3.3		No longer Boeing property
CB584	9/26/1997	51		No longer Boeing property
CB584	8/18/1998	31		
CB584	5/21/2000	213		
CB584	7/26/2006	9.3		
CB585	7/26/2006	0.56		No longer Boeing property
MH108	8/18/1992	426		8/24/2006
MH108	7/25/2006	6.6		
MH130	9/19/1997	11		8/24/2006
MH130	9/26/2005	2.3		
MH133D	9/26/2005	0.11		9/30/2005
MH179	9/22/1997	3.3		8/22/2006
MH179	8/7/1998	1.3		
MH179	5/4/2000	33		
MH179	9/26/2005	15.3		
MH179	4/26/2006	34		
MH179	7/25/2006	47		
MH179A	9/26/2005	3.7		8/22/2006
MH187	7/17/1992	180		8/21/2006
MH187	10/18/1996	0.58		

Table 4
Summary of NBF Catch Basin PCB Sampling

Location	Date Sampled	Total PCBs (mg/kg)	Date of Most Recent Cleanout
MH187	9/23/1997	49	
MH187	8/7/1998	27.2	
MH187	10/4/2005	9.2	
MH193	9/23/1997	47	8/21/2006
MH193	8/7/1998	50.1	
MH193	5/4/2000	47	
MH193	9/26/2005	84	
MH193	7/25/2006	191	
MH226	8/6/1998	46	10/13/2005
MH226	7/25/2006	15	
MH249	8/18/1992	49	10/10/2005
MH249	9/24/1997	98	
MH249	8/14/1998	80	
MH249	6/4/2000	91	
MH249	5/13/2005	12	
MH249	7/26/2006	11.2	
MH415	7/19/2000	25	10/5/2005
MH415	6/6/2005	13	
MH415	7/26/2006	3.8 U	
MH483A	6/4/2000	342	10/5/2005
MH483A	5/13/2005	3.5	
MH582	7/26/2006	1.4	No longer Boeing property
OWS132	10/8/1996	7	1/6/2006
OWS132	9/23/1997	22	
OWS132	8/10/1998	13.5	
OWS132	5/1/2000	46.8	
OWS132	9/26/2005	12	
OWS132	1/5/2006	7.3	
OWS153	8/10/1998	3.9	8/24/2006
OWS153	3/23/2000	9	
OWS153	1/5/2006	1	
OWS186	8/7/1998	234	8/21/2006
OWS186	5/4/2000	199	
OWS186	5/13/2005	33	
OWS186	9/26/2005	49	
OWS186	7/25/2006	1200	
OWS1-C	6/3/2000	11	1/18/2006
OWS1-C	1/13/2006	4.7	
OWS1-C	7/26/2006	2.2	
OWS226A	1/5/2006	32	2/9/2006
OWS226A	7/25/2006	17.4	
OWS421	8/12/1998	0.25	2/2/2006
OWS421	1/13/2006	3	
OWS472A	8/14/1998	13	2/2/2006
OWS472A	1/5/2006	5.6	
OWS483A	1/5/2006	6.6	1/19/2006

Table 4
Summary of NBF Catch Basin PCB Sampling

Location	Date Sampled	Total PCBs (mg/kg)	Date of Most Recent Cleanout
OWS483B	9/25/1997	110	NA
OWS483B	8/14/1998	54	
OWS483B	7/25/2006	3.6	
OWS640	5/20/2000	2.9	NA
OWS640	1/5/2006	2.6	

Table 5
Summary of PCB Concentrations in Joint Material Samples 2000/2001
North Boeing Field

Joint Material Type	Location	Sample Number	Date	Total PCBs (mg/kg)	Range of Detection Limits (mg/kg)
A	A-SP45	NBF-SP45-001109-A	11/9/2000	ND	5-10
A	A-SP55	NBF-SP55-010402-A	4/2/2001	ND	0.98-2
A	A-SP54	NBF-SP54-010402-A	4/2/2001	0.78 J	1-2
A	A-SP83	NBF-SP83-010404-A	4/4/2001	43	5-10
A	A-SP56	NBF-SP56-010402-A	4/2/2001	49	1-2
A	A-SP14	NBF-SP14-001107-A	11/7/2000	23,000	980-2000
A	A-SP65	NBF-SP65-010403-A	4/3/2001	68,000	2000-4000
A	A-SP66	NBF-SP66-010403-A	4/3/2001	79,000	2000-4000
B	B1-SP44	NBF-SP44-001109-B1	11/9/2000	ND	0.98-2
B	B2-SP26	NBF-SP26-001108-B2	11/8/2000	ND	0.98-2
B	B2-SP27	NBF-SP27-001108-B2	11/8/2000	ND	0.98-2
B	B2-SP40	NBF-SP40-001109-B2	11/9/2000	ND	1-2
B	B-SP32	NBF-SP32-001108-B	11/8/2000	ND	1-2
B	B1-SP12	NBF-SP12-001107-B1	11/7/2000	0.54 J	0.99-2
B	B1-SP12	NBF-SP13-B1-DUP	11/7/2000	0.66 J	0.98-2
B	B-SP04	NBF-SP4-001106-B	11/6/2000	0.78 J	1-2
B	B-SP16	NBF-SP16-001107-B	11/7/2000	1.1	0.99-2
B	B1-SP24	NBF-SP24-001108-B1	11/8/2000	1.2	0.99-2
B	B-SP25	NBF-SP25-001108-B	11/8/2000	4.3	1-2
B	B-SP08	NBF-SP8-001107-B	11/7/2000	41.9	0.98-2
C	C1-SP39	NBF-SP39-001109-C1	11/9/2000	ND	20-270
C	C-SP02	NBF-SP2-001106-C	11/6/2000	ND	0.99-2.5
C	C-SP43	NBF-SP43-001109-C	11/9/2000	ND	1-2
C	C2-SP73	NBF-SP73-010403-C2	4/3/2001	1	0.98-2
C	C-SP31	NBF-SP31-001108-C	11/8/2000	1.3	0.98-2
C	C2-SP64	NBF-SP64-010403-C2	4/3/2001	2.7	1-2
C	C2-SP72	NBF-SP72-010403-C2	4/3/2001	13	2000-5300
D	D-SP21	NBF-SP21-001107-D	11/7/2000	0.77 J	0.99-2
D	D-SP11	NBF-SP11-001107-D	11/7/2000	0.96 J	1-2
D	D-SP29	NBF-SP29-001108-D	11/8/2000	1.1	0.99-2
D	D-SP10	NBF-SP10-001107-D	11/7/2000	1.4	0.99-2
D	D1-SP17	NBF-SP17-001107-D1	11/7/2000	2.7	0.98-2
E	E-SP41	NBF-SP41-001109-E	11/9/2000	0.53 J	0.98-2
E	E-SP41	NBF-SP42-E-DUP	11/9/2000	0.55 J	1-2
E	E-SP03	NBF-SP3-001106-E	11/6/2000	5.2	0.98-2
F	F-SP05	NBF-SP5-001106-F	11/6/2000	ND	0.98-2
F	F-SP06	NBF-SP6-001106-F	11/6/2000	ND	0.98-2
F	F-SP36	NBF-SP36-001109-F	11/9/2000	ND	1-2
F	F-SP37	NBF-SP37-001109-F	11/9/2000	ND	0.98-2
F	F-SP38	NBF-SP38-001109-A	11/9/2000	ND	1-2.3
F	F-SP35	NBF-SP35-001109-F	11/9/2000	1.2	.98-2
F	F-SP07	NBF-SP7-001106-F	11/6/2000	3.1	0.99-2
G	G-SP20	NBF-SP20-001107-G	11/7/2000	6.1	0.98-2
G	G-SP75	NBF-SP75-010403-G	4/3/2001	14.1	1-2

Joint Material Type	Location	Sample Number	Date	Total PCBs (mg/kg)	Range of Detection Limits (mg/kg)
G	G-SP57	NBF-SP57-010402-G	4/2/2001	3,900	99-200
G	G-SP85R	NBF-SP85-010404-ResG	4/4/2001	4,200	490-980
G	G-SP70R	NBF-SP70-010403-ResG	4/3/2001	16,100	500-1000
G	G-SP76R	NBF-SP76-010404-ResG	4/4/2001	17,200	500-1000
G	G-SP61R	NBF-SP61-010402-ResG	4/2/2001	19,900	490-980
G	G-SP59R	NBF-SP59-010402-ResG	4/2/2001	20,000	490-980
G	G-SP67R	NBF-SP67-010403-ResG	4/3/2001	25,700	490-980
G	G-SP58	NBF-SP58-010402-G	4/2/2001	35,000	500-1000
G	G-SP30	NBF-SP30-001108-G	11/8/2000	35,300	990-2000
G	G-SP78	NBF-SP78-010404-G	4/4/2001	39,300	980-2000
G	G-SP33	NBF-SP33-001108-G	11/8/2000	50,000	980-2000
G	G-SP80R	NBF-SP80-010404-ResG	4/4/2001	57,000	2000-3900
G	G-SP78	NBF-SP79-DUP	4/4/2001	59,000	2000-3900
G	G-SP82	NBF-SP82-010404-G	4/4/2001	61,000	2000-3900
H	H-SP46	NBF-SP46-001109-H	11/9/2000	ND	0.98-2
H	H-SP48	NBF-SP48-001109-H	11/9/2000	ND	0.98-2
H	H-SP28	NBF-SP28-001108-H	11/8/2000	0.54 J	1-2
H	H-SP15	NBF-SP15-001107-H	11/7/2000	1.7	1-2
H	H-SP74R	NBF-SP74-010403-ResH	4/3/2001	1.8	1-2
H	H-SP47	NBF-SP47-001109-H	11/9/2000	3.9	0.98-2
H	H-SP88	NBF-SP88-010404-H	4/4/2001	4.4	1-2
H	H-SP86R	NBF-SP86-010404-ResH	4/4/2001	8.1	1-2.2
H	H-SP53	NBF-SP53-010402-H	4/2/2001	9	1-2
H	H-SP22	NBF-SP22-001107-H	11/7/2000	11.6	1-2
H	H-SP62	NBF-SP63-DUP	4/3/2001	13.7	1-2
H	H-SP62	NBF-SP62-010403-H	4/3/2001	17.3	1-2
H	H-SP09	NBF-SP9-001107-H	11/7/2000	19.9	1-2
H	H-SP77R	NBF-SP77-010404-ResH	4/4/2001	20.5	0.99-2
H	H-SP68R	NBF-SP68-010403-ResH	4/3/2001	20.9	1-2
H	H-SP84R	NBF-SP84-010404-ResH	4/4/2001	24	1-2
H	H-SP50	NBF-SP50-010402-H	4/2/2001	25.1	1-2
H	H-SP60R	NBF-SP60-010402-ResH	4/2/2001	42	1-2
H	H-SP81R	NBF-SP81-010404-ResH	4/4/2001	50	5-9.5
H	H-SP01	NBF-SP1-001106-H	11/6/2000	164	20-40
H	H-SP49	NBF-SP49-010402-H	4/2/2001	270	9.8-270
H	H-SP69R	NBF-SP69-010403-ResH	4/3/2001	2,240	100-200
I	I-SP19	NBF-SP19-001107-1	11/7/2000	ND	0.99-2
I	I-SP23	NBF-SP23-001108-I	11/8/2000	1.2	0.99-3
J	J-SP18	NBF-SP18-001107-J	11/7/2000	ND	0.99-2
J	J-SP34	NBF-SP34-001108-J	11/8/2000	1.1	1-2
K	K-SP51	NBF-SP51-010402-K	4/2/2001	ND	1-2
K	K-SP52	NBF-SP52-010402-K	4/2/2001	0.61 J	1-2
K	K-SP87	NBF-SP87-010404-K	4/4/2001	0.78 J	1-2

Notes:
Total PCBs consisted of Aroclor-1254 and Aroclor-1260.
Data for residual joint material is shown in yellow.